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ABSTRACT

This volume provides synopses of discussions at a meeting of project directors holding grants from the National Science Foundation for the development of instructional materials to be used in science and mathematics courses at the undergraduate and graduate levels. The focuses of these discussions were new degree programs, identification and evaluation of existing materials, transferability mechanisms, computer-related educational technology, audiovisual technology, and continuing education. Descriptions of the projects funded are provided in the appendixes to this volume. Each description includes the project name, purpose, intended audience, description of the innovative features, plans for evaluation, and comments concerning problems encountered. The projects described are quite varied in subject matter, level, and scope. (SD)

SCIENCE EDUCATION INFORMATION
REPORTS

Proceedings
Project Directors Meeting

Airlie House, Virginia
February 10-12, 1974

MATERIALS AND INSTRUCTIONAL DEVELOPMENT SECTION
DIVISION OF HIGHER EDUCATION
NATIONAL SCIENCE FOUNDATION

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1974

Preface

This publication has been produced with the cooperation of the National Science Foundation. Dr. John Snyder coordinated the publication for the National Science Foundation.

We hope the conference summary and program descriptions provide useful information regarding development of materials and programs for higher education.

Robert W. Howe, Director
ERIC/SMEAC

This publication was prepared pursuant to a contract with the National Institute of Education, United States Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent National Institute of Education position or policy.

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Airlie House Conference

Introduction

On February 10-12, 1974 project directors holding grants monitored by the Materials and Instruction Development Section, Division of Higher Education in Science of the National Science Foundation met at Airlie House outside of Washington, D.C. The participants also included members of the NSF staff, representatives of scientific and educational societies, and individuals who had a special interest in the topics to be discussed. Purposes of the meeting were to stimulate communication between the participants, and to solicit their thoughts and ideas concerning desirable future trends in science education. Six initial sessions were organized around the following topics:

a) New Degree Programs
b) Identification and Evaluation of Existing Materials
c) Transferability Mechanisms
d) Educational Technology--Computer-Related
e) Educational Technology--Audio-visual
f) Continuing Education

Following ten-minute summaries by the group chairmen in plenary session, the participants reconvened in three combined sessions on:

g) Educational Technology
h) Educational Materials
i) Educational Programs

The meeting concluded with a final session in which issues that had come to light earlier during the conference were discussed. Time was available during the conference for special meetings, individual discussions between participants, and study of a display of instructional materials prepared by the project directors in attendance.

As an experiment, video tape facilities were provided in all the sessions and participants were given the opportunity to make individual presentations for replay to the group.

We at the Foundation are appreciative of the vitality and vigor with which the participants expressed, confronted, and defended issues during this meeting. The complexity of the questions attached is implicit in the diversity of opinions presented; that they have not been resolved is not surprising. We have found these sessions stimulating and hope that other attendees have found them likewise. To Dr. Arnold A. Strassenburg our thanks for preparing the summary following.

First Round Discussion
(Condensed from summaries of the panel chairmen)

A) New Degree Programs

- Departments that focus narrowly on a single discipline contribute little toward the preparation of post-baccalaureate students for success in solving the complex technological problems facing modern society. Perhaps the departmental structure of universities needs reexamination.

- The success of new degree programs rests heavily on the energy and enthusiasm of the creators. Techniques must be developed for the translation of locally successful experiments to nationwide usage.

- Both faculty members and academic administrators resist innovation. Most teachers are too involved in daily activities to study possible alternatives to their current methods. Administrators, faced with tight budgets and escalating governance and personnel problems, tend to avoid risks. The campus reward structure does not place high value on instructional innovation.

- New degree programs frequently include internship arrangements. Based on the limited experience gained to date, observers view this trend favorably. Internships appear to provide not only valuable practical experience, but also contacts with prospective employers that lead directly to jobs for students after graduation.

- How is it determined that a particular baccalaureate degree program produces appropriately certifiable graduates? The consumers of the product should have an input to this decision, but the coupling is weak, and academic institutions have not discovered how to teach non-traditional knowledge and skills.

- The Doctor of Arts degree appears to be experiencing difficulty in gaining general acceptance. Different programs vary substantially from one another in level as well as content. This contributes to a lack of understanding concerning the level and the objectives intended for and achieved by D.A. programs.

- The history of science is playing a more important role in the design of curricula today than it did a few years ago. Historical topics provide needed links among the various scientific disciplines, and also help to establish a proper perspective of science viewed in its general social context.

B) Identification and Evaluation of Existing Materials

- It might be useful to conduct an in-depth survey to discover why some high-quality instructional materials--such as NSF-supported films-- are not more widely used.

- The issues concerning when and by whom project goals and activities should be publicized deserve further study. Despite the dangers inherent in the premature release of preliminary versions of new materials, the consensus was that information about a project and sample materials should be distributed early in the history of the project. Materials developers have failed as publicists and commercial publishers are not helpful until a demand is established. The value of substantial increases in the level of funding provided for publicizing newly developed materials in Federal grants should be considered.

- It is difficult for projects that are not supported by federal grants to achieve adequate exposure.

- Multidisciplinary projects suffer for lack of publicity because they are not advertised through the usual channels available to disciplinary societies.

- The motivation for an innovator to conduct a summative evaluation of his results immediately after completing the development of new materials is understandably weak. Some group members believe that such an evaluation, even if conducted competently, is less valuable than a review of the use of the materials conducted several years later. Others believe a summative evaluation that measures the extent to which the stated project objectives have been achieved is an essential component of every project that wishes to contribute to long-range improvement in instruction.

- Summative evaluations, even when conducted by evaluation experts, are not generally believed. This sorry situation will probably improve only when standards of performance for development projects have been produced and generally accepted by professional science educators.

- In any case, NSF should insist on the submission of post-project descriptions of the procedures used to develop and test new materials, and reports on all formative evaluations conducted.

- The professional societies could contribute significantly to information dissemination by periodically publishing descriptions of NSF-supported projects related to their interests.

- Among the most effective means for disseminating information about curriculum projects are the Cooperative College School Science institutes and the short courses offered on the Chautauqua circuits. Mechanisms such as these should be supported and exploited more widely.

C) Transferability Mechanisms

- High costs are the biggest barriers to the development and use of new instructional programs. Included among these are not only direct costs for salaries and materials, but also costs in career growth for the developers, publications costs, costs to the institutions which test and adopt the materials, and costs to the students who participate in evaluation experiments.

- Developers need the support of colleagues and administrators at their home institutions as well as encouragement from their professional societies. The creative development of new materials cannot thrive as a clandestine activity.

- The system for identifying and processing textbook material is well developed and operates successfully. A parallel system must be developed to test and deliver other kinds of instructional materials.

- The design and evaluation of delivery systems must move forward simultaneously with the development of new materials. Substantial progress on one front only is not wise, and perhaps not even possible.

- The Foundation should seek to optimize the mix of grants it makes to materials developers and systems researchers.

- A key to the wider use of available materials is the training of prospective teachers in the effective use of the materials.

- An effort should be made to identify the common denominators among successful products and to provide guidelines that would enable future developers to take greater advantage of the past experiences of others.

D) Educational Technology--Computer-Related

- Some participants suggested that no further projects should be attempted until what is most needed and what is successful becomes more clear. The majority of participants want to continue experimenting at the same time that evaluation techniques are improved.

- Who should determine what experiments are conducted? Unfortunately, high costs, in effect, leave the decision to the fund-granting agencies.

- The key to wider use of computer-related instructional materials is standardization that would make possible the transfer of instructional systems from one campus to another.

- There is at present a barrier at the interface where software is entered into a computer-based system. There is no general agreement concerning the superiority of large, centrally located computers with remote access terminals or small systems available on each local campus.

- Another serious barrier is the lack of generally accepted evaluation criteria for pedagogical effectiveness or cost effectiveness. This makes comparison between old and new systems, or large and small systems, very difficult. It is not even clear if one can evaluate a large system by building a small model, or if one must build the large system to test it.

E) Educational Technology--Audiovisual

- Audiovisual materials are designed for use by students, but teachers made the decisions concerning their adoption. More direct feedback from students about pilot materials they have used might increase the probability of the acceptance of the final product.

- Because the demand and usage of audiovisual materials is not great, feedback to developers is not readily available. The organization of trial user groups might help to alleviate this problem.

- Trial users seldom test an entire program. It is not obvious that a coherent system can be tested meaningfully in a piecemeal fashion. Perhaps programs should be designed with separable parts each of which can be tested and used in isolation.

- Evaluation efforts often fail because trial users fail to cooperate. It is also true that some evaluation schemes are poorly designed afterthoughts.

- A system that will provide convenient access to media-oriented materials has yet to be devised.

- Copyright regulations governing the use of audiovisual materials are not widely known. Developers often neglect to establish copyrights until it is too late to avoid plagiarism.

- There is a need to continue the development of experimental materials, even though substantial amounts of unused materials already exist. What is less clear is if future pilot materials can be evaluated in an unpolished form or if they must be produced in a slick and therefore expensive format.

- A serious problem that needs solution is how to interest print-oriented faculty members in media-oriented materials.

F) Continuing Education

- Adequate solutions to this problem will only result from study and cooperative action on the part of academic institutions, industrial firms, and professional societies.

- The wide dispersal of sources of and markets for continuing education programs reduces many programs below the threshold for profitable activity. The aggregation of these sources and markets would do much toward increasing the quality and quantity of continuing education.

- The dissemination of information about available opportunities must be improved.

- The problem in this area is more one of motivating the potential consumer than developing adequate instructional systems.

- Motivation for learning new skills is generated primarily when a technological breakthrough results in an abrupt change in manufacturing procedures. It may therefore be wise to couple the design of continuing education programs with technological progress.

- Professional societies could do more toward increasing the motivation of practicing scientists to upgrade their knowledge and skills. For example, requirements for periodic recertification would stimulate many to seek additional instruction.

- It is unlikely that existing societies will provide the needed leadership in this area. A new organization should be formed that would accept this responsibility.

- Industrial firms also fail to provide the stimulus that would cause their employees to seek advanced education and training. While management generally supports the concept of continuing education, supervisors are more interested in the improvement of existing skills through practice rather than the acquisition of new skills or knowledge.

- Society generally supports anti-intellectualism and thereby creates a major barrier for every person interested in continuing education.

Second Round Discussion
(Condensed from summaries of the panel chairmen)

G) Educational Technology

- Project directors in the United States should follow the lead of European educators and take cognizance of new developments in educational psychology.

- Project directors might learn how to teach certain subjects better by conducting surveys of successful learners.

- The NSF could contribute more to the evaluation of materials by holding conferences that bring together scientists and learning psychologists.

- NSF could provide support for the addition of evaluation consultants to the staffs of development projects.

- Copyright regulations that protect the developers of non-print materials need clarification and wider publicity.

- Regulations should be adopted that permit project directors to reinvest royalties from the sale of materials in the further development and refinement of materials.

- An organization should be created that could provide effective liaison between project directors and publishers while contract negotiations are under way.

- Short pieces of visual material should be designed and produced to serve as optional components of larger programs.

H) Educational Materials

This discussion group identified the following barriers to the dissemination of new materials and the implementation of new courses:

(1) Lack of feedback between producers and users.
(2) Lack of professional rewards for users.
(3) Lack of information about new materials.
(4) Lack of time to study and test new instructional methods.
(5) The high cost of producing pilot materials.
(6) Difficulties in maintaining adequate training programs for teaching assistants.
(7) The poor quality of some materials.
(8) Incompatibilities among software and hardware components.
(9) The indivisibility of most project materials.
(10) Lack of workshops and other teacher training opportunities.

Regional centers could aid dissemination efforts by performing the following functions:

(1) Communication with teachers through newsletters and workshops.
(2) Maintenance of collections of new instructional materials for study by interested teachers.
(3) Promotion of direct contacts between developers and users.
(4) The development of new materials.
(5) The evaluation of existing materials.

Professional societies can also play a vital role in stimulating educational change:

(1) They could help to shape a reward structure conducive to the creative development and testing of new materials.
(2) Societies could help to formulate:
    (a) guidelines on the implementation of new programs
    (b) standards of quality for new materials
    (c) review mechanisms
    (d) distribution mechanisms
    (e) information exchange channels
    (f) continuing education outlets
(3) Societies might even serve to promote innovations in some areas.

I) Educational Programs

- Resistance to change is normal; universities exhibit more than an average amount.

- Project success is not necessarily coupled to national access to project materials.

- The adaptability of materials is inversely proportional to their specificity.

- A consortium of colleges provides a good vehicle for the evaluation and dissemination of project materials.

- National advisory committees have assisted significantly in the development and promotion of some innovative programs.

- The process of certifying the professional competence of individual scientists needs review and modification. Professional societies must take the lead in this activity; NSF cannot make a major contribution in this area.

- The professional societies could do more to promote innovation in education, but they must take the initiative and determine for themselves what activities are consistent with their objectives and resources.

The Final Discussion Session

Opening Comments by A.A. Strassenburg

As I understand my role, I am to help lead you in a discussion of what NSF should do in the future in the area of science education. Since I am not a member of the NSF inner circle, I cannot say what they are likely to do or what the program officers would like to do. All I can really do is to say what I think NSF should do, or more appropriately, what I have heard the participants say, spoken with a single voice during the past two days. There have been some oft-repeated or at least loudly voiced themes. Here are some that I have heard:

(1) Academic institutions resist change. We need more effective methods of calling their attention to the possibilities offered by new degree programs, new materials, and new technologies.
(2) Individual faculty members resist change. The barriers to the adoption of innovative instructional systems are numerous and high. Among the most significant are a lack of incentives in the existing academic reward structure, lack of a felt need for change, the inferior quality of some new products, and the lack of both adequate information about materials and suitable models of new instructional systems.
(3) We need more effective dissemination systems for existing materials such as workshops, regional dissemination centers, and information retrieval systems, and we need more information about existing mechanisms such as ERIC and the Science Information Exchange. Professional societies could also help, but they need financial support.
(4) There should be continuing encouragement for the development of smaller units of instructional materials and systems. By this technique we can increase diversity in a cost-effective manner.
(5) To increase the influence of instructional innovation, we must solve problems of a political nature, as well as the usual problems concerning content and methodology.

(6) The wider use of educational technology awaits the generation of more software, the training of more skilled technical personnel, the modularization of systems and the standardization of systems components, and the reduction in cost of hardware.
(7) Continuing education will not thrive unless the incentives for students and faculty are increased, opportunities are better advertised, and the efforts of industry, academia, and the professional societies are coordinated.
(8) Meaningful evaluation of instruction requires careful planning and better funding, but developers must identify what and why they are evaluating, when to evaluate, what kind of evaluation serves their purposes, and how much evaluation is useful.
(9) Developers themselves disagree on the major problems as well as on the solutions. This suggests that support for research on the effectiveness of instructional systems is at least as important as support for materials development.
(10) The proliferation of largely unevaluated materials and programs, greater expectations, higher instructional costs, a decline of educational productivity, and decreases in institutional and federal support for education have created a crisis for educators. We need the continuing financial support of NSF for promising research and development in education, and we need their moral support in our efforts to justify to a skeptical public and a cost-conscious administration quality education for all who seek it.

This list of needs includes few specific recommendations. Maybe this is because there was so little agreement among us. Maybe it is because I couldn't hear individual pithy ideas among the forest of voices in this room. You will have another opportunity soon to speak your mind loudly and clearly.

Discussion Summary

Following a description of the FY 74 budget, questions were raised on several issues. These can be classified among the following categories: (1) criteria for the selection of NSF program emphases; (2) NSF proposal review procedures; (3) methods of exploiting the media to improve science education, particularly continuing education. The following is a summary of these questions and comments, and also related remarks that were made throughout the discussion period that followed.

Conferees exhibited intense interest in the process of establishing project categories and funding levels for NSF science education programs. The responses to questions concerning the elimination of or sharp reduction in support for some old program categories, such as institutes and conferences for science teachers, revealed that current policies discourage programs that 1) provide benefits primarily for individuals, and 2) attempt to provide problem solutions using means that require continuing support. Additional questions explored interactions between scientists, Foundation officers, other administration personnel, and congressmen concerning desirable levels of funding for various NSF programs. In particular, an effort was made to understand who is responsible for final budget decisions. Apparently there is substantial interaction between NSF staff,

other executive branch personnel, and Congress and its staff; compromises result that do not always coincide with the preferences of scientists. However, the final budget submitted to Congress is prepared by NSF officials. Congress makes modifications in a fashion that is responsive to the expressed wishes of its constituency.

Some participants inquired about the proposal reviewing process. In particular, concern was expressed lest narrowly trained persons from a single discipline be allowed to determine the fate of proposed educational projects that are fundamentally interdisciplinary. Participants were informed that reviewers are broadly chosen, and that persons experienced with projects similar to that proposed provide the most valuable comments.

There was a lengthy exchange that explored methods of using the mass media more effectively to communicate with the public on science--particularly social science--issues, and to provide science education for specific groups. There is a "Public Understanding of Science Program" that is budgeted under the Science Education Improvement Program and is administered by the Office of Government and Public Programs. Grants have been made to support the wide dissemination of information about science and society issues. The fact that few suitable proposals have been submitted was interpreted as evidence that scientists do not know how to use the mass media nor how to interact effectively with public media programmers. Several participants spoke of the real opportunities that exist to prepare science-based programs that would be welcomed by educational and cable television stations, particularly the latter.

Participants heard and reacted to statements concerning our responsibilities to train scientists and engineers for developing countries, the possibility of establishing a remote-access instructional materials center, the scope and current directions of continuing education, and the considerable value of interactive conferences.

An appeal was made for the creation of a major facility to improve substantially the ability of science teachers to learn about and gain access to available instructional materials. A model that was discussed pictures a single center that contains materials classified in various ways on computer storage disks. Teachers at remote terminals would be able to dial codes that would call up all materials satisfying specified selection criteria. One person suggested that there should be global access to this center. Attention was called to existing centers that include some of the features of the model described above: The Ethnographic Film Study Center (New England) and Clearinghouse for Audiovisual Materials operated by the medical profession (Atlanta).

There were both positive and negative reactions to this suggestion. On the negative side, one person stated that what education needs most is more meaningful personal contacts among teachers and learners. Another warned against the belief that easy solutions can be found to difficult problems; he contended that there is no simple way to shorten the time it takes to produce, disseminate, and evaluate instructional materials. It was observed that such a center would be expensive to construct and operate, and that education is generally under-capitalized. Perhaps an

essential first step to any ambitious new venture is the establishment of a public education corporation and the organization of pressure groups who would press continuously for an adequate flow of funds.

On the positive side, some participants felt that a dial-access materials repository would be a step forward even if not the final answer to all dissemination problems. In particular it would partially relieve developers of the burden of marketing their own products, a burden they bear very ineffectually. Another participant pointed out that more ready access to software would be timely considering that hardware systems, such as cable TV, will soon be seeking good materials.

Naturally, suggestions for less ambitious solutions to the dissemination problem came forth. The important contribution that professional societies make when they display new materials was cited. One person claimed that the common tendency of creative teachers to go home and improve on what they have seen rather than adopt it is the best kind of dissemination. Another called attention to the role local institutions can play by providing convenient opportunities for faculty members to review films and other new materials. Appeals were made for the preparation of better catalogs, annotated bibliographies, and careful reviews of existing materials. A participant described the problems and the success that one experimental institution has experienced in creating a library that catalogs and shelves large amounts of non-print materials. Another conferee commented briefly on an "interactive TV" project that permits access to software from home learners, and invited input from the assembled participants to his library of materials.

Continuing education as an unsatisfied need arose repeatedly during the discussion. There was a request for suggestions about how to expand most effectively in this area. One point was made strongly: continuing education is a very broad problem. There are many special interest groups in addition to industrial scientists that constitute potential markets for continuing education programs. The trick is to reach them; this will require the design of novel delivery systems and support mechanisms. Significant improvement in the current spectrum of opportunities will require the cooperation of industry, academia, and government. Rapid improvement should not be expected; noticeable results will follow successful efforts by five to ten years.

Finally, interactive conferences, like the one here reported, were the subject of analysis and praise. It appears that for many there is no better way to communicate new ideas than by demonstrations and face-to-face discussions. Specific conference recommendations and lengthy proceedings are not essential components of a successful conference. Professional societies partially satisfy the need for scientists to meet. NSF staff members were urged to arrange more meetings of educators like this one, but involving even broader mixes of systems experts and creative developers.

Appendices

Meeting Schedule

SUNDAY, February 10, 1974

7:00 P.M. Busses leave airports for Airlie House; Dinner on arrival followed by short orientation meeting. Display materials set up.

MONDAY, February 11, 1974

8:00 A.M. Breakfast

9:00 A.M. Special Interest Sessions

A. Educational Technology - Computer Related: John J. Allan and Joseph J. Lagowski
B. Educational Technology - Audio-Visual: John P. Jordan
C. Transferability Mechanisms: Robert J. Toft
D. Continuing Education: J. Munushian
E. New Degree Programs: Keith B. Mather
F. Identification and Evaluation of Existing Materials: Robert W. Howe

12:00 Noon Lunch

2:00 P.M. Summaries of the special interest sessions

3:00 P.M. Coffee

3:30 P.M. Combined Sessions

G. Educational Technology A+B
H. Educational Materials C+F
I. Educational Programs D+E

6:00 P.M. Social Period. Opportunity to examine and discuss materials

7:30 P.M. Dinner

8:30 P.M. Demonstrations and Films

TUESDAY, February 12, 1974

8:00 A.M. Breakfast

9:00 A.M. Individual demonstrations and discussion

10:30 A.M. Combined Sessions, 1, 2, and 3

12:00 Noon Lunch

1:30 P.M. Summaries of sessions 1, 2, and 3

2:00 P.M. Final Session. Some Future Directions, Francis G. O'Brien and Arnold A. Strassenburg, moderators

5:00 P.M. Busses to airports and downtown.

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Dr. Terence L. Porter - Fellowships and Traineeships Section, HES

Dr. John L. Snyder - Materials and Instruction Development Section, HES

Dr. Alice P. Withrow - Materials and Instruction Development Section, HES

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PROJECT DESCRIPTIONS

Geophysics

PROJECT TITLE: EXTERNAL DEGREE PROGRAM--M.S. AND PH.D.

PROJECT DIRECTOR: K. B. Mather

PROJECT ADDRESS: Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

PURPOSE:

The primary purpose in offering external degrees is to open a new avenue to continuing education beyond the baccalaureate. Many persons of high ability cannot afford the costly years of regular study in residence at a university. The external degree program makes it possible for such persons to study for higher degrees while remaining in full-time employment.

A secondary purpose is to explore alternative (and much more flexible) routes to the Ph.D. and M.S. for persons having the ability, the requisite facilities, and the motivation to undertake independent study.

Some potential consequences of the external degree concept, if it proves successful, are: (i) By making it possible for scientists and engineers in other walks of life (industry, government labs, etc.) to obtain the formal certification of an advanced degree, their mobility will be improved. In particular, a healthier exchange between academe and industry may develop. (ii) As the cost of study under the external degree regulations will be borne mainly by the candidate, who presumably is able to pay because of full-time employment, the substantial subsidy which State universities generally apply to graduate education will be avoided.

AUDIENCE:

The program is aimed particularly at scientists who are professionally employed in government organizations, industrial laboratories, the military, non-profit research institutes, consultantships, etc. It may also prove helpful to school teachers. It may have some appeal to minority groups and women who, in the past, probably experienced more difficulty in obtaining assistantships and fellowships for conventional graduate study. The program is not closed to candidates from university and college faculties, though it was not designed for them.

INNOVATION:

The principal distinction of the program is the lack of a residence requirement. There will be very little personal contact between the candidate and his faculty committee, except for an initial interview, inspection of the candidate's facilities, and the thesis defense. The emphasis is on independent study. Courses will be conducted by correspondence; completion of a course will require passing an examination. The self-motivation required to successfully complete such a program is

expected to be a useful filter. A comprehensive application form is sent to all enquirers--a form designed to establish as thoroughly as possible the candidate's background, opportunities for research, attitude of the employer, colleagues available for discussion, ideas on research topics, etc.

UNIVERSITY PROCEDURES:

The University has established a small Administrative Steering Committee which has the overall 'watchdog' role on behalf of the University (to ensure that the high standards of the Ph.D. and M.S. are maintained, to recommend a scale of fees, to provide liaison with other programs at the University, etc.). Applications from prospective candidates are reviewed by a large group, the Panel on Admission of Candidates for the External Degree. The latter group is responsible for acceptance of candidates and for naming an appropriate faculty advisory committee (including at least one external examiner, i.e. from another university) to guide the program of each candidate.

PROBLEMS:

This program has not been in operation long enough to define problems on the basis of actual experience. Some of the anticipated difficulties are: (i) How to evolve objective and consistent criteria for evaluating written applications from persons with a wide range of backgrounds, often including training experience of a kind not obtained in formal universities. (ii) How to conduct all required kinds of courses by correspondence. The mechanics of this will doubtless present many difficulties and will take time and experience to streamline. (iii) Persons in private industry may encounter obstacles to release of proprietary material for thesis purposes. A similar problem may occur with classified material. The precise selection of thesis topic and the full cooperation of the employer are essential. (iv) The proper costing of external programs and realistic fee-setting.

ADDITIONAL COMMENTS:

The external degree program was initiated by the University of Alaska in 1973 on a trial basis. It is presently restricted to geophysics and closely related fields. In principle, the program could be extended to other branches of science and engineering and (presumably) to other fields of scholarship. Results of the Alaskan experiment are expected to be transferable to other academic institutions.

External degree programs are envisaged as additional to, not a replacement for, the traditional in-residence graduate program of universities.

Geography

PROJECT TITLE: COMMISSION ON COLLEGE GEOGRAPHY

PROJECT DIRECTOR: John F. Lounsbury

PROJECT ADDRESS: Commission on College Geography
Arizona State University
Tempe, Arizona 85281

PURPOSE:

The major purpose of the Commission on College Geography and its panels is to work in various ways to improve geographic programs at the college level compatible to the broader educational needs of colleges and universities throughout the nation. This necessitates continuing investigation and development and distribution of materials concerning the overall role that modern geography should play in college curricula, including programs of study in geography and programs of study to which geography should contribute significantly. Specifically, the major objectives of the Commission and its working panels are to:

1. develop approaches to integrate geographic programs within the broader higher education context, including participation in interdisciplinary curriculum efforts;

2. develop and publish pertinent materials to facilitate the incorporation of recent developments and recent research in undergraduate programs;

3. advise individuals and institutions in strengthening geography curricula;

4. investigate ways and means to increase the effectiveness of undergraduate courses, including the development of new techniques of presentation; and

5. generate, discuss and develop new schemes to improve undergraduate geography courses and programs.

AUDIENCE:

Instructors and students involved in undergraduate college geography courses and programs. The materials developed by the Commission have been widely used by college geography instructors and students as well as persons in related fields in this country, Canada and abroad.

INNOVATION:

The aspects of the project that appear to be innovative are:

1. Developing a variety of innovative publications to modernize undergraduate college geography courses and programs and a series of publications for formal consulting work or to be used as self-evaluative aids for college geography departments (See Section on Materials).

2. Organizing Regional Conferences in six areas, geographically dispersed in the country, to bring together local college instructors, from both two-year and four-year institutions to discuss problems such as program development in the two-year colleges; subject matter innovations in undergraduate college courses; and communication among geographers in state colleges, private colleges, and large universities. These conferences were not part of a nation-wide program but it appears that knowledge gained from the six centers will have broad applicability, serve as "demonstration" centers, and that the strengthened professional ties will be self-perpetuating without the Commission's continued participation.

3. Organizing specialized Summer Institutions for College Teachers, in cooperation with selected universities, to familiarize participants with new materials and techniques. Further, the Commission organizes special sessions and workshops to be held in conjunction with the Annual Meetings of the Association of American Geographers as well as national and regional meetings of other professional organizations.

4. Normally, the Commission and its working panels hold their meetings on college campuses and formally or informally discuss the work of the Commission and problems in college geography with the staff of the host and neighboring institutions. This arrangement has proved to be successful as a communication device and in the involvement of a large number of college instructors throughout this country and Canada.

EVALUATION:

In the spring of 1971, the Commission was evaluated to determine what the impact its activities have had as of that date. This evaluation was supervised by J. Thomas Hastings, Director, Center for Instructional Research and Curriculum Evaluation, University of Illinois. A questionnaire was distributed to approximately 1,000 members of the Association selected on a structured random sample basis. The results of this evaluation indicated that the profession was exceptionally well aware of the Commission's work and its activities have been quite successful.

Further, it is the opinion of the project officers that the work of the Commission is very well received. These opinions are based on the large number of requests for publications and letters of inquiry.

MATERIALS:

The Commission and its working panels have developed, published, and distributed the following documents:

GENERAL SERIES

The General Series of publications are designed for widespread use by instructors of college geography courses and related fields. The documents that have developed to date are:

1. Geography in Undergraduate Liberal Education, 1965.

2. A Basic Geographical Library: A Selected and Annotated Book List for American Colleges, 1966.

3. Geographic Manpower: A Report on Manpower in American Geography, 1966.

4. New Approaches in Introductory College Geography Courses, 1967.

5. Introductory Geography: Viewpoints and Themes, 1967.

6. Undergraduate Major Programs in American Geography, 1968.

7. A Survey Course: The Energy and Mass Budget at the Surface of the Earth, 1968.

8. A Systems Analytic Approach to Economic Geography, 1968.

9. A geographical Bibliography for American College Libraries, 1970.

10. Geography in the Two-Year Colleges, 1970.

11. Manpower in Geography: An Updated Report, 1972.

12. Planning College Geography Facilities: Guidelines for Space and Equipment, 1973.

13. Perspectives on Environment, 1974.

RESOURCE PAPERS

The Resource Papers are designed for student use as well as the instructor. The topics of these documents are concerned with important subject matter which is not normally included in current texts nor readily accessible in current literature. These papers translate recent research developments and conceptual ideas into documents from which instructors of undergraduate courses can select to supplement existing text material. The Resource Papers developed to date are:

1. Theories of Urban Location, 1968.

2. Air Pollution, 1968.

3. Perspectives on Geomorphic Processes, 1969.

4. Spatial Diffusion, 1969.

5. Perception of Environment, 1969.

6. Social Processes in the City: Race and Urban Residential Choice, 1969.

7. The Spatial Expression of Urban Growth, 1969.

8. The Political Organization of Space, 1971.

9. An Introduction to Spatial Allocation Analysis, 1971.

10. Man and Nature, 1971.

11. Tropospheric Waves, Jet Streams, and United States Weather Patterns, 1971.

12. The Spatial Structure of Administrative Systems, 1972.

13. Residential Mobility in the City, 1972.

14. The Periglacial Environment, Permafrost, and Man, 1972.

15. Conservation, Equilibrium, and Feedback Applied to Atmospheric and Fluvial Processes, 1972.

16. Metropolitan Neighborhoods: Participation and Conflict Over Change, 1972.

17. Computer Cartography, 1972.

18. Society, The City, and The Space-Economy of Urbanism, 1972.

19. Thematic Cartography, 1972.

20. Man and Environment, 1973.

21. The Use of Radar Imagery in Climatological Research, 1973.

22. Misused and Misplaced Hospitals and Doctors: A Locational Analysis of Urban Health Care Crisis, 1973.

23. Values in Geography, 1974.

25 - 28:

Inter-Urban Systems and Regional Economic Development, 1974.

The Underdevelopment and Modernization of the Third World, 1974.

Citizen Participation, Advocacy and Dissent, 1974.

Multifunctional Organizations and Systems of Cities, 1974.

TECHNICAL PAPERS

The Technical Papers are designed for college geography instructors as they modify their existing courses and programs. The Technical Papers developed to date are:

1. Field Training in Geography, 1968.
2. Computer Assisted Instruction in Geography, 1969.
3. Evaluating Geography Courses: A Model with Illustrative Applications, 1970.
4. Living Maps of the Field Plotter, 1971.
5. Simulation of the Urban Environment, 1972.
6. Computerized Instruction in Undergraduate Geography, 1972.
7. The Interface as a Working Environment: A Purpose for Physical Geography, 1972.
8. Land Use: A Computer Program for Laboratory Use in Economic Geography Courses, 1972.
9. Bibliography of Statistical Applications in Geography, 1972.
10. Multidimensional Scaling: Review and Geographical Applications, 1973.

CONSULTING SERVICES PUBLICATIONS

Geography as a Discipline, 1973.

Sources of Funds for College Geography Departments, 1973.

Planning College Geography Facilities: Guidelines for Space and Equipment (CCG General Series No. 12), 1973.

Community Internships for Undergraduate Geography Students, 1973.

Undergraduate Program Development in Geography, 1973.

A Geographical Bibliography for American College Libraries (CCG General Series No. 9), 1970.

Guidelines for Consultants (Internal Document), 1974.

Single copies of all publications, currently in print, may be obtained free of charge upon request. Publications may be purchased in bulk quantities by individuals, bookstores and organizations. Requests should be addressed to:

Commission on College Geography
Geography Department
Arizona State University
Tempe, Arizona 85281

PROBLEMS:

The difficulties in developing the project, although perhaps not to be considered as critical or serious, revolved around the organization of manpower. In the early stages of the project, considerable time was spent in channeling the efforts and enthusiasm of individuals along productive tracts and getting them to work together. A perennial problem has been to select the right persons to serve on the Commission and its working panels -- individuals who are highly competent in their field of specialization and at the same time are willing to expend a great deal of effort with little or no tangible rewards. The Commission officers have had to work continuously to maintain a fine balance in combating negative attitudes and lack of appreciation for committed tasks on the one hand, and not prohibiting creativeness and innovative ideas on the other.

In general, the success of the Commission's work leads me to believe that the basic framework is sound and I would utilize the same or similar framework if I were to do it again. No doubt minor changes in organization of panels and definitions of tasks could be made for the better the second time around.

ADDITIONAL COMMENTS:

Since its establishment in 1963, the Commission has operated under the auspices of the Association of American Geographers. This arrangement has been most fortunate as the members of the Central Office of the Association have always been very cooperative and seriously interested in the work of the Commission. The excellent support and help of the Association has been most essential to the success of the project.

Further, in all my contacts and dealings with the personnel associated with the National Science Foundation, I have found them to be highly professional, helpful and eminently fair.

PROJECT TITLE: COLLEGE SCIENCE IMPROVEMENT PROGRAM (COSIP)

REPORTED BY: Marion B. Smith

PROJECT ADDRESS: California State College
Bakersfield, California

DESCRIPTION:

The faculty in mathematics and the sciences is regarded as resource persons for students enrolled in these courses - as facilitators of the learning process. In this case the learning process is being enhanced by the development of autotutorial, course content modules in a variety of media. These modules, being developed by the faculty and consultants during summer writing sessions under this grant, will be used in various complementary and supplementary ways in each course. In many cases the units will serve to relieve the faculty member from time consuming instruction in routine areas such as the use of equipment or the learning of detailed classifications. The student will be able to proceed at his own pace, with a wider variety of learning experiences than might otherwise be available to him. He will also assume more responsibility for his own education. The instructor will then be free to serve as a consultant to the student, and to assist with individual projects and learning experiences.

This project is coming to completion this academic year (1973-74), so that evaluation is now in progress. A summary and evaluation conference will be held on May 10-11 in Bakersfield. Aside from the objectives and modules, some of which will be displayed at the conference in Virginia, other materials are not yet ready, although additions will be available by February.

Chemistry

PROJECT TITLE: CHEMICAL TECHNICIAN CURRICULUM PROJECT

PROJECT DIRECTOR: Robert L. Pecsok

ASSOCIATE DIRECTORS: Kenneth Chapman and Wade H. Ponder

PROJECT ADDRESS: Lawrence Hall of Science
University of California
Berkeley, California 94720

PURPOSE:

ChemTeC sought to devise a curriculum and supportive instructional materials in chemistry for the unique requirements of students preparing to become chemical technicians.

AUDIENCE:

The primary audience for the instructional materials are two-year college students in chemical or science technology curricula. These students may not have had previous experiences in chemistry and will normally be from the middle one-half of the high school graduating classes. A secondary audience includes those needing to acquire practical knowledge and skills for particular techniques applicable to chemical laboratory work.

Curriculum recommendations and content descriptions as provided through the textual materials are used by colleges and technician employers in planning or modifying programs designed for training and upgrading of technicians.

INNOVATION:

ChemTeC textual materials demonstrate a significant departure from "standard" chemistry programs planned for individuals seeking employment in chemical laboratories. Laboratory skills are emphasized. Rather than being used to demonstrate concepts, experiments are used as a foundation for developing concepts. Topics are introduced when needed rather than where tradition suggests. (A good example is the location and treatment of gas laws. They are introduced in a comprehensive discussion on sampling immediately preceding work on gravimetric and titrimetric analytical techniques.) Motivation is maintained through widespread use of experiments using real samples and application of instrumentation typically used by modern laboratories.

Mathematics is introduced where needed and does not require formal use of calculus although calculus concepts are introduced very early. A spiral approach is used to provide reinforcement.

EVALUATION:

Curriculum recommendations were reviewed by committees and given widespread distribution. Textual materials were used in twelve pilot colleges that provided almost all conceivable conditions under which the texts could be used on a college campus. Some were large; others were very small. Some were well equipped; others started with virtually no laboratory facilities. Some had long-established chemical technology programs; others were completely new to the field. Some faculty were favorably disposed to the program; others were resentful at having a program forced upon them by an administration.

In addition to feedback provided by pilot college faculty members who were on the ChemTeC Writing Team, students were interviewed extensively to identify their perceptions of problems.

Industrial and government consultants reviewed ChemTeC materials as they were being developed.

Due to the short time span, evaluation focused on the effectiveness of the instructional materials for teaching purposes rather than upon the effectiveness of program graduates after they became technicians. Employer input was directed toward assuring that the correct topics were being adequately presented.

MATERIALS:

Products of the ChemTeC Project include a seven volume series, Modern Chemical Technology; a Guidebook for student use; a comprehensive Teacher's Manual; and The ChemTech, a 16 mm, color, sound motion picture designed for orientation and recruitment. All of the text materials were revised after classroom use.

All of the ChemTeC products are available from:

Books Department
American Chemical Society
1155 Sixteenth St., N.W.
Washington, D.C. 20036

PROBLEMS:

Careful preliminary planning and personnel selection permitted avoidance of many potential problems. Goals were reasonably clear. A centralized writing team operation facilitated communication and minimized duplication of effort. Location of ChemTeC at the Lawrence Hall of Science at Berkeley, California, gave access to experts in photography and graphics as well as laboratory, office, and secretarial accomodations. Development of in-house capability for preparing camera-ready copy permitted the establishment of exceptionally close deadlines which were seldom missed.

Pilot colleges were selected to be representative of institutions that would use ChemTeC materials. As a result, ChemTeC made no attempt to impose a specific pattern on the colleges. The variation in extent and depth of coverage of ChemTeC materials was wide. However, this was not considered a serious problem.

On a second time around, there would be very few changes. The principal changes would pertain to reducing the time for selecting distributors of the text materials and film.

One significant difficulty has arisen relative to project continuation. In retrospect, it appears that it would have been desirable for the project to give colleges a chance to use the ChemTeC materials for several classes prior to issuing a second edition of the Teachers Manual. We now would like to thoroughly review existing media supplements for use in ChemTeC programs.

Combining such a review with production of additional useful media supplements would greatly ease the burden of faculty offering the program while improving the quality of program seen by the student. The additional expenditure of about 5 percent of the total grant for the project would provide great benefits.

Computer Science
Engineering

PROJECT TITLE: DEVELOPMENT OF AN EDUCATIONAL COURSE SEQUENCE FOR DIGITAL CONTROL OF CHEMICAL PROCESSES

PROJECT DIRECTOR: Duncan A. Mellichamp

PROJECT ADDRESS: Department of Chemical and Nuclear Engineering
University of California
Santa Barbara, California 93106

PURPOSE:

To develop a new undergraduate course in real-time digital computing, then utilize concepts taught in this course in laboratory experiments added to two subsequent chemical process dynamics and automatic controls courses.

AUDIENCE:

The real-time computing course originally was intended to be taught to undergraduate engineering students. It now is obvious that its potential audience is much broader. Presently we are offering the course to all undergraduates with prior computing experience and anticipate much broader participation, particularly from computer science students.

INNOVATION:

Probably the strongest innovation has been in designing the course to allow students much more hands-on time to interact with the computer system. This has required that experiments be designed and built which require little supervision over relatively long time periods and which demonstrate the key elements of real-time computer-process operations. As an example, we have built a small model railroad to use in multitask programming instruction. The object-simultaneous control of a number of trains around the layout - is exciting to students and at the same time furnishes an excellent programming challenge with unambiguous results.

EVALUATION:

Students involved in the course sequence are furnishing formalized evaluations including specific comments for evolutionary changes which they would like to see incorporated.

MATERIALS:

Not available until August, 1974. We expect to have available a set of class notes covering the real-time digital computing course; "modules" describing construction, operation, experimental write-ups and results for three interactive experiments; and a description covering use of the digital computer in the process dynamics and control laboratory. A preliminary version of this last item is available now from the project director.

PROBLEMS:

Major problems have been in equipment construction (mechanical more than electronic) and in building-up and maintaining the computer system. In a second "go-round" I would wish to stabilize development of the laboratory computer at an earlier stage so as to be able to spend full time on course and experimental development.

Multidisciplinary
Engineering Practice

PROJECT TITLE: ENGINEERING CASE PROGRAM

PROJECT DIRECTOR: Henry O. Fuchs

PROJECT ADDRESS: Department of Mechanical Engineering
Stanford University
Stanford, California 94305

PURPOSE:

We provide samples of real engineering work suitable for use in classrooms in order to motivate students; to exercise their abilities in dealing with unprepared problems; to provide material for research on the practice of engineering; and to encourage professors to take a good look at the engineering world outside schools.

AUDIENCE:

We address the case pamphlets to classroom teachers and students. Freshmen and graduate students use them more than the intermediate classes. We address collections of cases to engineering libraries. About 200 schools have used case pamphlets in classes. Seventy-five libraries buy the annual collected volumes of cases. Several published books include some of our cases. The potential audience is much greater.

INNOVATION:

We try to show how engineering actually is done - not how it should be done nor what the successful steps to conclusion were. This reportorial approach is very rare. Engineering literature consists mostly of editorials and of success stories.

EVALUATION:

Gradual growth of the use of cases is one measure of success. We also have the intuitive feeling that we provide a useful unique service.

MATERIALS:

About 200 case pamphlets have been published. They are available from the Engineering Case Library, Room 500, Stanford University, Stanford, California 94305.

PROBLEMS:

The most serious difficulties in collecting the material are the reluctance of engineers to spend time recalling the steps which they took and the difficulty of writing a readable account. The most serious difficulty in using the material is the tendency to follow a formula, for instance, the so-called case method, without carefully adapting it to the specific needs of a class. A further difficulty comes from the previous training of engineering students with many well defined single answer problems. It takes time and repeated attempts before students derive much benefit from cases. This difficulty does not arise with freshmen.

Environmental Science
and Engineering

PROJECT TITLE: THE ENVIRONMENTAL SCIENCE AND ENGINEERING PROGRAM AT UCLA

PROJECT DIRECTOR: Richard L. Perrine

PROJECT ADDRESS: University of California
Los Angeles, California 90024

PURPOSE:

This is a new professional doctorate program which has as its objective preparation for the study, analysis and assessment of a broad range of environmental problems. The aim of this interdepartmental graduate program is not to produce experts in the narrow, traditional sense of the word, but to train graduate students with sound backgrounds in the sciences or engineering as environmentalists able to work within the existing framework of technology, applying research done by others to the problems in question.

AUDIENCE:

The program is addressed to that group of students able to work at the doctoral level, with broad environmental interests, and who wish to become problem solvers as contrasted with researchers. At present, eight doctoral students enrolled in the program have progressed to the internship stage, 15 are enrolled as first or second year doctoral students, and five are working toward M.S. degrees at UCLA with fellowship support and plans to continue into the doctoral program. The first degree will be awarded this year. The potential audience is limited by the number of students of doctoral caliber, but the need for qualified problem-solving leadership is quite large. We believe that the potential audience is substantially larger than the 50 to 75 maximum which can be accommodated at a time in the UCLA program.

INNOVATION:

The Environmental Science and Engineering program does not offer classroom courses itself; students enrolled in this program take advantage of the wide variety of courses offered by the traditional science, engineering, public health and social sciences departments existing on the UCLA campus. The course program is flexible and varies according to the background of each student. As an example, a typical student with a bachelor's degree would

a. earn a master's degree in an established discipline to insure that he has sufficient disciplinary depth within a particular area of science.

b. take additional courses in areas peripheral to his specialty, and certain social science courses, in order to obtain the breadth necessary to work on problems which are nearly always multidisciplinary in nature.

c. spend one year at the University as a member of a multi-disciplinary team participating in an intensive problem-solving experience.

d. take an oral qualifying examination for advancement to candidacy.

e. spend one-and-one-half to two years at an outside institution gaining applied research experience.

f. prepare written and oral reports on his applied research experience during a final quarter at UCLA.

The program includes two unusual aspects:

1. the "problems course"; a year-long intensive, multidisciplinary team study of a significant environmental problem. This has proved to be one of the most valuable learning experiences for students and faculty alike. Students particularly enjoy the fact that they can apply what they have learned academically to real-life problems.

2. the extended internship experience. This feature has also proved to be very successful. The students have the opportunity to function as professionals and apply their training in a real-world situation. The host institutions have been most pleased with the high quality of the work done by students who serve as interns with them, and in nearly all cases have requested that we send them more interns.

EVALUATION:

The program will be evaluated by faculty and administrative bodies within the University of California system in the Fall of 1974.

MATERIALS:

The team studies conducted as "problems course" work are documented as Environmental Science and Engineering reports. All are being made generally available through University Microfilms in Ann Arbor, Michigan. Many of these constitute very valuable reference material for other groups aspiring to work in the subject areas. Title of those published to date are given below.

FINDINGS, RECOMMENDATION, EXPLANATION--AIR POLLUTION AND CITY PLANNING*

RESEARCH INVESTIGATION--AIR POLLUTION AND CITY PLANNING, Case Study of a Los Angeles District Plan - S431.

FACING THE FUTURE: FIVE ALTERNATIVES FOR MAMMOTH LAKES - S-429

ENVIRONMENTAL, TECHNICAL, LEGAL AND SAFETY ASPECTS RELATED TO FLOATING NUCLEAR POWER PLANTS OFF THE COAST OF CALIFORNIA - S-432.

APPENDICES TO ENVIRONMENTAL, TECHNICAL, LEGAL AND SAFETY ASPECTS RELATED TO FLOATING NUCLEAR POWER PLANTS OFF THE COAST OF CALIFORNIA - S428.

WATER QUALITY AND RECREATION IN THE MAMMOTH LAKES SIERRA - S-430.

FUTURE ALTERNATIVES FOR THE SANTA MONICA PIER.*

* These titles have not yet been processed by University Microfilms; contact the Office of Environmental Science and Engineering, UCLA, Los Angeles 90024 for information on their availability.

Multidisciplinary

PROJECT TITLE: MASTER'S DEGREE PROGRAM IN SCIENTIFIC INSTRUMENTATION

PROJECT DIRECTOR: Virgil Elings

PROJECT ADDRESS: Physics Department
University of California
Santa Barbara, California 93106

PURPOSE:

The purpose of the project is to develop a graduate curriculum to provide training and experience in scientific instrumentation for students whose backgrounds are in any area of science or engineering.

AUDIENCE:

During the past two years, students with Bachelor's degrees in Physics, Chemistry, Biology, Psychology and Chemical, Electrical and Nuclear Engineering have enrolled in the Program.

INNOVATION:

The philosophy of the Program, which has worked quite well, is to have the students learn through their own motivation by working on real instrumentation problems in research labs on campus and in local hospitals. The Program has developed to give the students the widest possible range of areas to work in to guarantee that they find an area of intense interest and challenge to them.

EVALUATION:

The Instrumentation Program has recently been evaluated by the Physics Department by asking for written evaluations from a) former students, b) faculty outside the Physics Department who have had our students working on their instrumentation problems, c) and medical doctors in the local hospitals who have had students working with them. The evaluations of the Program was very favorable, with the students feeling that it opened up their opportunities in science and the faculty and doctors being glad to have students working on their research problems.

MATERIALS:

The students have developed state-of-the-art instruments in areas of Cellular Biology, Marine Biology, Mechanical Engineering, Nuclear Medicine, Cardiac Diagnosis, Physics, Speech and Hearing, and Chemistry.

ADDITIONAL COMMENTS:

For students whose backgrounds are totally different, the format of having students work on their own projects with little formal lecturing works very well. Because the students are usually very interested in their projects and know that it's not just an exercise, their morale is very high and their days very long. If we were to start over, we would develop the Program the same way.

Optics

PROJECT TITLE: O.T.I. PROJECT

PROJECT DIRECTOR: Barclay J. Tullis

PROJECT ADDRESS: Optics Technology, Inc.
934 Charter Street
Redwood City, California 94063

PURPOSE:

The philosophical purpose of this project is to create a cluster of teaching Units with which educators can evaluate the viability of applying a systems approach in the management, development, and maintenance of curriculum materials.

AUDIENCE:

The materials produced in this project are aimed for intermediate, college level courses in Optics. They have been tested so far only by a few selected students, both undergraduates and graduates. Currently, the materials are in the hands of two-dozen professors scattered across the country, for testing and improvement. It is intended that these materials will have a greater audience in teachers and curriculum developers of all subjects.

INNOVATION:

There are five (5) important innovative characterizations which implement the systems concept of this program:

1) The lines of division, drawn in reckoning the boundaries of content in each teaching Unit, are explicitly recorded for use as interfacing data. (A Unit is 1-3 hours of study material.) These are stated in the form of a content overview, educational objectives, uses, and prerequisites.

2) The organization and relative significance of content within each Unit is highlighted and labeled by sentence-long paraphrases subtitling each paragraph or short group of paragraphs. These are phrased in a manner for communicating the primary learning objective of each paragraph (for those which have one).

3) Each statement of a learning objective (either terminal or transitional) is identified as to its level of intellectual sophistication. This is accomplished for each objective by giving the name of a category from a taxonomy developed of types of knowledge and intellectual proficiency in science. It is hoped that the process of categorizing will lead materials developers to a better organization of content, and to direct their emphasis toward developing useful proficiencies in the students.

4) Dividing curriculum materials into individual, separable elements (Units) has the outcome that each element can be maintained and kept current by individual authors who are experts in the subject field, with a minimum of individual effort and time. Also, a cluster of elements (Units) can be organized and tailored by its users to adapt to a wide variety of teaching methods and individual student needs, and provide a variety of alternative, controlled level, learning sequences.

5) This project is being carried out by a small industrial firm engaged in the subject field. Although initial organization of content, selection of Unit topics, and writing of text has been accomplished by a few individuals, with help from a local university, the materials are now being improved and perfected by outside educators, with the industrial firm managing the process. This is the first stage in which the viability of the systems approach will become visible.

EVALUATION:

Our evaluations to date have been primarily those given by N.S.F. We have tested some of the materials on selected students (some undergraduates and some graduates). As mentioned above, our materials are currently being improved and tested by professors distributed across the country. Our materials are to be completed by 30 April 1974.

MATERIALS:

We have 12 teaching Units for Interference and 10 for Diffraction. In addition to text, we have a kit of experiment apparatus specifically designed for these Units, several computer-aided exercises on punched paper tape, one 16mm "field-trip" type film, two computer-animated films, and several storyboards. We are currently continuing our development of the text materials only.

These materials are not available at the present time, due only to the costs of reproducing them. However, requests from potential contributors are greatly encouraged.

PROBLEMS:

Problems have been many. Here is a suggestive list:

1) Achieving the independence properties of a Unit. Loosing some continuity of style and thought. Balancing repetition.

2) Finding unambiguous definitions of knowledge and proficiency types.

3) Achieving a successful paradigm for a Unit to define its architectual details (its innovative features).

4) Maintaining a schedule for materials completion.

5) Absence of inputs from a larger audience in the Unit topic and objectives planning stage.

6) Maintaining a constant work force.

7) Communicating requirements and concepts of the system to the outside contributors by mail.

8) Costs of reorientation and learning new pedagogical concepts with each change in the project goals.

RECOMMENDATIONS:

1) Borrow existing materials for use as core text until architectual details of the ideal Unit become perfected.

2) Place contract emphasis on developing a single model Unit first, and log changes made as the philosophy is further developed.

3) Apply systems approach with cycles of improvement to the initial topic selection stage.

4) More frequent evaluation of the viability of developing concepts.

5) A flexible statement of work to permit following a logic-tree path in methods research.

6) Separate budgets for a) management of project and b) testing and improvement of materials by outside contributors.

Electrical Engineering
Computer Science
Mathematics

PROJECT TITLE: PART-TIME GRADUATE ENGINEERING DEGREE, CONTINUING EDUCATION AND RETRAINING BY INTERACTIVE INSTRUCTIONAL TELEVISION

PROJECT DIRECTOR: Jack Munushian

PROJECT ADDRESS: School of Engineering
University of Southern California
Los Angeles, California 90007

PURPOSE:

In September, 1972, the USC School of Engineering established a 4-channel ITFS interactive instructional television system broadcasting courses "live" from the campus to the Los Angeles industrial community with one of the largest concentrations of scientists and engineers in the world. Courses are normally broadcast to employees where they work. Audio response is also provided over ITFS and a daily courier service delivers and picks up class materials.

The purpose of the NSF sponsored program is fourfold:

1. To assist in developing the system for part-time graduate education and also for continuing education for industry employees who have been out of school for some years.

2. To accelerate penetration by the system of local industry by creating two "regional" television classroom facilities in areas with heavy concentrations of high technology companies.

3. To take advantage of the greater visibility of Master's degree engineering curricula afforded by television in encouraging industry personnel to evaluate their present level of preparation in a specific field of engineering.

4. To study the role of the television system in removing psychological, physical or financial disincentives to the pursuance of a program of continuing education.

AUDIENCE:

The program is presently addressed to the following audiences:

1. Part-time graduate students in engineering, computer science and to a lesser extent, mathematics, who must work in local industry in order to carry on a graduate degree program.

2. Industry personnel who are interested in continuing education in the aforementioned fields. They may take the identical courses as offered to degree students but as non-degree students who receive a course grade or simply as passive auditors. They may also take special noncredit continuing education courses.

3. The system is also being used to a lesser extent for continuing education for high school mathematics and science teachers.

INNOVATION:

Interactive instructional television systems linking schools of engineering with industry and government are not new but there has been significant growth of such activities in the last five years.

The innovative aspects of the NSF supported program at USC are:

1. The development of the concept of urban regional classrooms designed to permit industry employees to drive one or two miles to television classrooms rather than tens of miles to the campus.

2. A study of the factors that inhibit industry employees from staying current with their fields through continuing education (i.e., travel, time, convenience, cost). This study is allied to a separate NSF grant on the study of the transportation-telecommunications trade-off.

EVALUATION:

1. Discussions with students taking courses over television.

2. Statistical studies on growth of television enrollment.

3. Questionnaires, particularly in connection with the transportation-telecommunications trade-off study.

MATERIALS:

Some special continuing education courses and design-oriented engineering courses for industry personnel. Course outlines are available from J. Munushian.

PROBLEMS:

No major problems except that effective dissemination of information about programs in regional classrooms to employees of nearby companies is presenting some difficulty.

PROJECT TITLE: PEST POPULATION ECOLOGY:
AN INTER-UNIVERSITY TRAINING PROGRAM

PROJECT DIRECTOR: P. S. Messenger

PROJECT ADDRESS: Department of Entomological Sciences
University of California
Berkeley, California 94720

PURPOSE:

Awarded for the period 1 July 1969 to 30 June 1971, extended to 31 October 1973, includes Cornell University (D. Pimentel, Integrated Project Director), University of California, Berkeley (C. B. Huffaker, Sub-project Director), University of California, Riverside (P. DeBach, Subproject Director), North Carolina State University (D. E. Davis, Sub-project Director), Oregon State University (P. Oman, Subproject Director).

This training program provides an inter-regional, interdisciplinary experience for doctoral students in the field of ecology, with emphasis on pest population ecology. Students in the program, though based at the campus of choice, are transferred for short periods of time (up to a semester) to another campus in the program, depending upon the subject of their dissertations and varied expertise at the campuses. In a similar way, participating faculty visit each campus to present lectures and seminars too, and hold conferences and participate in discussions with the students at the respective campuses.

The major purpose of this program is to bring together into one postgraduate educational experience elements of animal population theory and applied pest population control and management. In the past, and still evident to the present time, practical pest control education in our Land Grant Universities has been compartmentalized and overly simplified. The result has been the modern dependency, and all too often the active advocacy, on unilateral and anti-ecological applications of chemical pesticides. The awareness that pest control is really an ecological problem, requiring a framework of population theory, has been recognized in only a few institutions. These few institutions frequently are those that support active programs of research on such ecological approaches to pest control as biological control, or host plant resistance, or crop culture modification. This program exposes the graduate student to the latest experimental and theoretical developments in the natural control and regulation of numbers as a background and framework within which to explore, refine, and apply ecologically sound methods for the practical suppression of pests.

AUDIENCE:

This program is for graduate students in entomology, zoology, botany, or biology, who wish to pursue a course of training and research in pest population ecology. The graduate student audience can then be described bi-dimensionally: (a) students specializing in insects, mites,

rodents, birds, or weed plants, and (b) those interested in environmental biology, population ecology, applied ecology, or pest control.

This program, at Berkeley, has been over-subscribed since its beginning in 1969. Another way of describing its potential audience is to point out that in 1969 there were 19 students enrolled in the graduate program in entomology who had "declared" for biological control as a field of emphasis, while in 1973 this number has grown to 38.

INNOVATION:

Innovative educational procedures in this program include (a) exchange of students between participating institutions, (b) exchange of participating faculty between institutions for presentation of lecture series, seminars, and discussions, and (c) blending of basic (theoretical) and applied ecology in a synergizing way. Student shifting among institutions broadens experiences and outlook, promotes an integrative attitude in regard to pest ecology, challenges the student who otherwise holds a parochial view of his subject. Faculty shifting provides a similar broadening advantage to the trainee, but in addition stimulates local staff and non-participating students with a new or challenging or oppositional scientific view.

EVALUATION:

This project has neither proceeded long enough nor included a large enough sample of trainees to enable a comparison of performance or accomplishments (grades, thesis). It has been underway for three years, and only in the past year have any students completed his training.

No external evaluation has been made or planned.

MATERIALS:

Not applicable.

PROBLEMS:

The major problem has been the exchange of faculty instructors among institutions. Those individuals who have made such exchanges did so for only very limited periods of time. This was because they were unable to give up their "home institution" responsibilities for more than a week or so at a time. Such short periods prevented them from entering into regular course schedules, or to have courses devised specifically to fit their own unique competencies.

A revised program would include arrangements for exchange of faculty for minimum periods of one full teaching period (semester, trimester, quarter).

Science Education

PROJECT TITLE: A PROJECT IN UNDERGRADUATE EDUCATION

PROJECT DIRECTOR: Fred Reif

PROJECT ADDRESS: The University of California
Berkeley, California 94720

PURPOSE:

The purpose of the project was to develop forms of programmed instruction suitable for teaching conceptual and problem-solving skills of the kind useful in science courses (such as physics) where the ability to use concepts is of prime importance.

AUDIENCE:

The audience used as an experimental population has consisted of college students who are taking an introductory physics course in preparation for careers in the biological or medical sciences. Experimental materials prepared for one quarter of this course have been used to carry almost the entire burden of instruction in a self-paced (Keller-plan) course format.

INNOVATION:

The innovative aspects probably include the following: (1) The formulation of some explicit instructional strategies (based on models of processes used by skilled self-learners) designed to teach a working knowledge of relationships (laws or definitions) and of simple problem-solving skills. (2) The development of flexible branched forms of written programmed instruction which are based on such explicit instructional strategies and which are clearly organized so that their structure and goals are apparent to students. (3) The goal of making such instructional materials self-contained so that they can act as non-human private tutors which can provide every student with effective high-quality instruction with a minimum (or no) reliance on intermediaries (such as teaching assistants or other instructors).

EVALUATION:

The most important evaluation necessary for our purposes is concerned with diagnosing specific student learning difficulties and thinking patterns since such detailed information is essential to improve teaching strategies and to revise instructional materials. Such detailed information has been obtained by examination of individual student responses on the learning materials, by interviews and observation of selected students, and by some specially designed diagnostic tests. In addition, information of a grosser kind has been collected by performance tests and by some questionnaires. Some statistical comparisons between student groups taught in different ways are now in progress.

MATERIALS:

The project has not been aimed at producing exportable materials. Hence the materials which have been written represent various stages of revision and are of uneven quality. (Some of these materials could, however, be made available to interested persons.)

PROBLEMS:

Several problems involved the need to do planning of the kind which can achieve a desirable modularity while maintaining high over-all coherence, particularly when striving to teach generalized skills which require teaching strategies consistently deployed over a prolonged period of time. In retrospect, our earlier planning could have been appreciably better. In addition, it should have paid greater attention to achieve our goals by means which would be as efficient and economical as possible.

Engineering

PROJECT TITLE: TESTBED FOR EDUCATIONAL EXPERIMENTS

PROJECT DIRECTOR: Donald A. Dunn

PROJECT ADDRESS: Engineering-Economic Systems Department
Stanford University
Stanford, California 94305

PURPOSE:

To make the type of interactive technology expected to exist in cable television systems of the future available to educators today. Future educational uses of two-way cable television depend on the development of educational software and the understanding by educators of the use of this new technology. This project is an equipment grant intended to make some equipment of this type available at Stanford in a usable form.

AUDIENCE:

The initial audience (users) of this technology will be Stanford faculty. The project equipment is not yet complete, so it has not yet been used. Once experiments are performed, they will be reported by the faculty performing the experiments.

INNOVATION:

Making this new technology available in an educational setting early in its development cycle, while changes can still be made before nationwide deployment is complete.

EVALUATION:

Only a preliminary evaluation will be made within the scope of this equipment grant, because no funds are available for research. It is intended that the equipment installed under this grant will be the first phase of a more extensive installation of cable and cable terminals at Stanford. Experiments using this equipment (including detailed evaluation) will then be designed and, hopefully, funded and carried out.

MATERIALS:

None

PROBLEMS:

Only technical problems so far. The real problems are expected in the future.

ADDITIONAL COMMENTS:

Two kinds of systems will be made available under this project.

One is an in-class digital student response system, based on hardware developed by T. B. Sheridan of MIT. It is a very simple system in which each student has a 10-position switch at his desk. A small "computer" calculates how many students have their switches tuned to a given number and prepares a histogram display which can be shown to the students and their instructor on TV monitors in the classroom. Remote TV students also see the display, but cannot vote in the present system. This system is similar in function to students raising their hands. It provides a rapid, simple communication medium for in-class use which could be extended to large classes in which the students are in homes or offices and are viewing the instructor and responding via a cable television network. This system is complete.

The other system is intended for individualized use and is close in design and function to the Mitre Corporation TICCIT system. Conventional TV sets are supplemented by alphanumeric keyboards and by local single-frame memories to provide a form of computer terminal suitable for use in cable television systems. This system is intended for use with CAI and library-type software like the SPIRES system. It will be connected to the Stanford Computer Center when it is in operation. It is not yet complete.

Economics

PROJECT TITLE: THE UNIVERSITY OF CALIFORNIA AT SANTA BARBARA MASTERS DEGREE PROGRAM IN URBAN ECONOMICS

PROJECT DIRECTOR: Perry Shapiro

PROJECT ADDRESS: University of California
Santa Barbara, California

PURPOSE:

The Masters Degree in Economics with an emphasis in Urban Economics is an eighteen month program in public sector management and policy analysis. The program is designed to introduce the student to scientific management techniques and to demonstrate how the techniques can be used to form policy in local government. The program consists of one year of course work, on campus, and six months of internship with various public agencies.

DESCRIPTION:

The Urban Economics program, started over a year ago with the aid of a National Science Foundation grant, has on the whole been a successful experiment. Students in the first year of the program are now completing the internship phase of their training and will soon be leaving the University. The response from agencies using our interns has been generally enthusiastic and their projects have worked out very well. Among the studies completed or nearly completed by our interns are an Input-Output model of Ventura County; two benefit-cost studies of public recreation in the City of Ventura; a capital improvement budget for the City of Pismo Beach; a study of the economic effects of a building permit moratorium in Santa Barbara County; and a study of the patrol configuration for the Santa Barbara County Sheriff.

The Urban Economics program was begun as a special option within the general Department of Economics Masters Degree Program. It was so started (rather than seeking a new degree designation) because the procedures for obtaining University approval of a new degree are very tedious and time consuming. It was the department's feeling that, although there was a good possibility that the program as conceived would be approved, the process for seeking such approval would be long and costly in terms of departmental manpower. It was our feeling that the energies spent in seeking approval for a new degree could be better spent getting the program underway. Furthermore, by starting in a small way we could early evaluate the success of our efforts. We could more easily change, or, indeed, dissolve the program than if we were locked into a formal degree structure as imposed by the University administration. When the program finally evolves into a successful form (groups of courses and internships), formal degree recognition will be sought.

EVALUATION:

Although we feel the program is generally successful we are in the process of revising the curriculum in response to needs that became apparent during the first internship period. The NSF grant has helped finance not only the student policy research, but also a whole new module

of courses related to the skills of public policy analysis. The courses initiated with the help of the National Science Foundation are as follows: (1) Economics 205A and 205B, these are two courses on the economics of decision making, it presents an operations research approach with examples of public sector problems. (2) Economics 140, this course deals with statistics applied to public sector research. Students in the course are taught econometrics as well as computer programming (both skills have been particularly valuable to the performance of the interns). (3) Economics 131, this course deals with public sector accounting and budgeting. It also concerns itself with the politics of local public sector budgets. (4) Economics 123, this course covers concepts of macro economic theory in which the concept of the multiplier is developed but the major concern of the course is to develop the techniques of input-output analysis. This course was not included in the first year program, but the demands placed on the interns by their employers indicated that the skills developed in the course were not only needed in the public sector, but also were in short supply. A second area where the curriculum needs strengthening is in politics and administration. With the economics courses the students learn the nature of optimum decisions, but they do not learn that the ultimate decisions must be taken within political environment. In order to cover this problem we are negotiating with the UCSB Department of Political Science to design a two quarter sequence on Local Politics and Public Administration. These courses will focus on the political realities of public decision making.

Biology

PROJECT TITLE: BIOCO-TIE CONSORTIUM

PROJECT DIRECTOR: John Patrick Jordan

PROJECT ADDRESS: Consortium of Institutions in Colorado
Colorado State University
Fort Collins, Colorado 80521

PURPOSE:

Under the leadership of North Eastern Junior College, a unified request from the two-year colleges of Colorado was made to Colorado State University to develop a program in undergraduate biology which reflects the modern trends of research and education in this discipline. The two-year institutions stressed their competence in freshman biology courses and expressed a need for assistance in providing a quality sophomore core. As a result, the Project BioCO-TIE consortium was established in the spring of 1970.

From the initial meeting a spirit of collegiality, cooperation and interaction among personnel of the participating institutions has forged a dynamic instrument to increase effective teaching talent at the college level. Its effectiveness is observed in the superior instructional packages produced, continuity of course offerings and increased student interest in biology.

AUDIENCE:

The consortium has provided complete instructional packages for the classrooms in sophomore biology at thirteen Community Colleges in the State of Colorado and Colorado State University. The three core courses, Ecosystem Biology, Cell Biology and Developmental Biology are being offered in classes ranging from fewer than ten students at the two-year colleges to approximately 200 students at the university. Instructors at Colorado University, Northern Colorado University and Ft. Lewis College are experimenting with an entire instructional package or portions thereof and adapting it to similar courses at their institutions. In addition, Project BioCO-TIE (BCT) media are being used by 2 two-year college instructors in a variety of biology courses as an enrichment element.

Although usage of the educational package developed by Project BioCO-TIE has been basically restricted to Colorado, discussions are underway for regional and national exposure.

INNOVATION:

The innovations relating to the BioCO-TIE consortium are as follows:

1. A major university is responding to the needs of the two-year colleges--not dictating their needs.

2. Program development was a coordinated consortium effort not a missionary effort by "Big U".

3. Educational media development has been exposed to peer evaluation committees composed of two-year college instructors and university professional and technical personnel for approval.

4. A complete educational package was produced in each class i.e., lecture notes, laboratory exercises, test questions, 2x2 color slides, single concept color TV tapes, session approach sheets and references.

5. 3/4" color TV tape cassettes are used to present video taped material.

6. Briefing and debriefing conferences involving all production and instruction personnel are held prior to and at the end of each course.

7. "Squawk Box" (an inter-campus telephone system) communication permits one to one or group discussion by instructors throughout the quarter.

8. The instructor has complete freedom to use or not use materials and methods in each course.

9. Internal and external evaluation programs were initially established to measure the effects of the program.

EVALUATION:

Too many educational endeavors are initiated and developed without providing sound evaluation to determine their merits. From the beginning, Project BioCO-TIE has established as one of its primary objectives · EVALUATION. An internal evaluation team from The Human Factors Research laboratory at Colorado State University is geared to measure both intellectual factors in terms of course content mastered and non-intellectual factors in terms of student attitudes towards the methods and materials used as well as behavioral objectives. Finally an external evaluation team coordinated by the American Institute of Biological Sciences, is charged with determining the success of Project BioCO-TIE and its potential exportability as a model for establishing consortia for undergraduate biology elsewhere in the nation.

MATERIALS:

Course notes in outline form are available for the instructor and student. Session approach sheets are provided to the instructors to assist in reaching the session objectives and to explain how the color slides and TV tapes may be incorporated into the instruction. The major thrust in single concept TV tapes (range from 5 to 19 minutes) is to provide educational experiences which are unavailable to the normal classroom instructor. The number of color TV tapes and color slides per course vary from approximately 40 to 1,000. Finally, a core of laboratory experiments are available for each BCT course. In those exercises requiring considerable preparation, an instructor's manual is made available.

Information regarding the availability of Project BioCO-TIE materials may be obtained by contacting Dr. John Patrick Jordan, Project Director, 205 Biochemistry and Radiation Biology, Colorado State University, Fort Collins, Colorado 80521; Telephone Number, 303-491-5371.

PROBLEMS:

As with all cooperative projects, problems developed that stimulated the imagination. In general it has been possible to minimize their effects and progress along a projected time schedule. The problems inherent with the consortium effort were:

1. The ability to anticipate the costs essential in providing travel, equipment, materials, and professional and technical staff.

2. The ability to select qualified professional and technical staff and to maintain a sustained commitment from them.

3. The necessity of having a dedicated staff assistant on the Colorado State University campus to coordinate all aspects of the consortium, i.e., media production and distribution; conferences, meetings, evaluation, information and news releases; funding and expense projects.

ADDITIONAL COMMENTS:

In closing, it must be emphasized the unique freedom by which participating instructors are allowed in utilizing the BioCO-TIE educational materials in their courses. This is providing a maximum of academic freedom and diversified testing of the project materials.

Chemistry

PROJECT TITLE: INTENSIVE MODULAR GRADUATE SHORT COURSES IN CHEMISTRY

PROJECT DIRECTOR: Robert A. Osteryoung

PROJECT ADDRESS: Department of Chemistry
Colorado State University
Fort Collins, Colorado 80521

PURPOSE:

To remedy a problem existing at the graduate level in areas outside of chemistry which, nonetheless, require a high content of chemistry, a program to develop a series of "short courses" is proposed. These courses would be patterned to meet, primarily, the needs of the non-chemistry graduate student who must make use of principles, practices and instruments associated with chemistry as a core discipline. Intensive modules, lasting one to three weeks each, would be developed; both "theoretical" modules, requiring some prerequisites, such as physical chemistry, would be offered as well as more "practical" modules, which would have a few prerequisites beyond a first-year chemistry background. The practical modules would have laboratory work associated with them.

AUDIENCE:

As indicated above, this program is aimed primarily at non-chemistry graduate students who require more chemistry than they obtain at the undergraduate level. It would also be useful for chemistry graduate students interested in some of the courses for specific purposes. At this writing none of the modules have been offered. However, at Colorado State we estimate a potential audience of 100-200 graduate students per year.

INNOVATION:

In general chemistry departments do not make an effort to provide service courses for non-chemistry graduate students, though of course at the undergraduate level most of their instruction is for non-chemistry students. That a need exists is manifested by interest to the program shown on the campus prior to submission of the N.S.F. proposal. We do not anticipate great innovation in terms of things done elsewhere in the preparation of the modules, although a good many of the procedures will be innovative insofar as our own campus goes.

EVALUATION:

An Advisory Committee, consisting of several members of Departments at whose students this program is aimed,has been established. This committee will provide us with both advice as to needs of various areas, and also feedback on their perception of our success - or lack of it, as the case may be. In addition, we intend to prepare questionnaires to be returned by students in the course which will try to determine if the program, in fact, really meets their needs.

MATERIALS:

Materials are being developed; these will consist of rather complete short-course notes, graphs, etc. These will be available from either of the P.I.'s as the modules are offered and refined. A good deal of audio-visual supplies are being obtained - films, slides, tape cassettes, etc. These are available from commercial sources and will serve to supplement the program.

PROBLEMS:

We have not progressed far enough to answer this question in a meaningful manner. We have had problems getting underway, in part because of the fact that we have lost one faculty member who was going to participate in this program, and also because we have had another going on Sabbatical. The University has also decided to change from a quarter to a semester system, which has complicated our efforts to get underway. We have encountered some difficulty in getting around the registration and credit problem for a course offered on a less than unit time (presently quarter) basis. However, the administration has gone to some lengths to overcome this difficulty.

Electrical Engineering
Telecommunications

PROJECT TITLE: MASTER'S PROGRAM IN TELECOMMUNICATIONS

PROJECT DIRECTOR: Frank S. Barnes

PROJECT ADDRESS: University of Colorado
Boulder, Colorado 80302

PURPOSE:

The program in Telecommunications was generated to provide a bridge between electrical engineering and the social sciences within an area of active national interest. The problems associated with the development of our telecommunications industry are mostly multidisciplinary in nature and require a diversity of talents and backgrounds. The program developed at the University of Colorado with the National Science Foundation support is designed in an attempt to meet some of the needs for manpower in this area.

AUDIENCE:

The program has appealed largely to students with five to ten years experience and some interest in telecommunications industry. Approximately 30 percent of the graduates are military officers who have had substantial communication responsibilities. Others are students who have been associated with the telephone company or regulatory bodies. A few have been industrial users of telecommunications systems, and a few students have come directly from liberal arts programs and are looking for a more vocational background. More than 1500 inquiries have been received about the program in its two years of existence. There are currently more than thirty students in the program. We believe this program is unique in its mix of technical and social science activities. I know of no other program that involves as much technical information for students with liberal arts or non-science backgrounds and which involves as much social science for students with engineering and technical backgrounds. We believe we may have something to offer the groups which are considering the development of interdisciplinary programs on subjects that include social or political problems or have a substantial technical component. Related programs might be developed in urban planning, environmental control, pollution and the delivery of medical care. In each of these cases, solutions to social and political problems are limited by the scientific and engineering technology which is available. New solutions to problems in these areas involve not only the understanding of the social and political elements of the problem, but also an understanding of the technical feasibility of alternative solutions. We believe the program which we have developed is the first to effectively tie together such diverse elements of a university as electrical engineering, finance, political science, law, and speech and drama.

INNOVATION:

The program which has been developed includes a sequence of four technical or semi-technical courses in electrical engineering, and at least four courses from the social sciences. Although there are no

absolutely required courses, the objective of the program is to expand the horizons of the student beyond the disciplines which he took as an undergraduate. Thus, students with bachelor's degrees in the social sciences or liberal arts are challenged by technical courses which require some of the vocabulary of electrical engineering associated with the telecommunications industry in areas such as electromagnetic field theory and radio propagation, information theory, queuing theory and reliability. At the same time, the students with engineering backgrounds expand their horizons to include courses in economics, political science, sociology, law, and occasionally the speech and drama departments. All students take some work in technical and nontechnical areas. It is hoped that the program provides the students with the essential background necessary to work in the telecommunications area on a broad class of management problems. The program is not expected to make engineers out of political scientists or social scientists out of engineers, however it does expect to provide both groups of students with enough knowledge of the whole range of the subjects to be involved in making telecommunications policy.

EVALUATION:

Our evaluation is that the program has been a marked success thus far. It is to be noted that we have been forced to turn down a significant fraction of the students whom we feel are qualified to enter the program for lack of faculty to supervise student projects. The course material in the program and the seminars are significantly broadening the horizons of the participating faculty. The fellowship support from the International Communications Association is also a sign of support. This industrial group has given us excellent support with seminars, general publicity, and requests to interview graduates for job opportunities in their corporations. In view of student responses to the program, and their general satisfaction with the kind and quality of the material which they have learned, we feel we are providing them with a useful increase in their understanding of the problems associated with the telecommunications industry. The important judgement will have to come in several years when the accomplishments of these students can be examined.

MATERIALS:

It should be noted that we have had inquiries from a variety of universities about the nature of the program and an indication that related programs are being set up at several schools. There are a variety of notes and other materials which are in the process of being developed for various courses; however, none of these are in published form.

PROBLEMS:

One of the difficulties with the program is that there are no well-developed textbooks available for the courses which have been especially designed for this program. We hope to develop a set of laboratory experiments to help students get a better feel for the equipment that is involved.

A variety of problems have occurred in the development of this project. First, it is difficult to coordinate the diverse group of faculty in a variety of schools and colleges. The six different depart-

ments and schools report to different deans and need to go through different procedures in order to free an instructor to teach a course which lies outside his normal activities. This problem has limited our ability to find the staff to develop an appropriate course in computing. However, we have succeeded in getting most of the faculty support we desired. We would like students to have access to a course on elementary software programming problems, hardware, and computer architecture.

ADDITIONAL COMMENTS:

We believe our project has been an exciting educational experiment. Its value will be determined by the careers of the graduates and its influence on further developments in other university programs. I would like to acknowledge that it was the National Science Foundation support that made it possible to get this program off the ground and developed to the point where it is in the process of becoming a part of the university's regular activities. Without the National Science Foundation's support we would not have had the capital to develop the program or to convince some reluctant deans that this kind of an educational experiment was worth the effort.

Multidisciplinary

ASSOCIATION: American Association for the Advancement of Science
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036

REPORTER: Arthur H. Livermore

During the past decade the Office of Education of AAAS has carried out many science education activities both at the pre-college and at the post-secondary levels. Some of the post-secondary projects are described below.

In 1963 a publication, Guidelines for Science and Mathematics in the Preparation Program of Elementary School Teachers was prepared by a joint project of AAAS and the National Association of State Directors of Teacher Education and Certification (NASDTEC). During the 1960's a dramatic revolution in the teaching of science and mathematics in elementary schools made changes in the preservice education of teachers imperative. Therefore, in 1969, new guidelines and standards for the preservice science education of elementary school teachers were prepared with the advice and assistance of almost 500 scientists, teachers and teacher educators. The new guidelines, published in 1970, emphasize objectives of instruction and teacher performance rather than specifying courses to be taken. The guidelines are addressed to all persons -- scientists, teacher educators, administrators, state department of education personnel -- who are concerned with the improvement of the preservice science education of elementary teachers.

In 1971 AAAS in collaboration with NASDTEC published Guidelines and Standards for the Education of Secondary School Teachers of Science and Mathematics. These guidelines, like the first edition which was published in 1961, are offered as resources for all persons interested in the preparation of teachers of secondary school science and mathematics. The guidelines were developed from statements prepared by four working committees on (1) the nature of science and mathematics and implications for the teaching of science and mathematics, (2) the necessary preparation of the mathematics teacher in mathematics and other areas, (3) the necessary preparation of the science teachers in the areas of science and mathematics, and (4) the strategies for the teaching of science and mathematics. The statements from the committees were reviewed by some 450 persons at three regional conferences, and the recommendations made at the conferences were considered carefully in preparing the final report. The twelve guidelines in the report describe skills needed by teachers and suggest strategies for helping future teachers acquire the desired competencies.

In 1967 the AAAS Office of Education conducted a survey (carried out by Surveys and Research, Inc.) for NSF on the preparation and teaching activities of junior college teachers of science and related technological subjects. The report of the survey, published by NSF in 1969, provided for the first time a reliable basis for some generalizations about science

education in the junior colleges and showed that there was a surprising degree of academic strength in the junior college faculties and a large amount of activity among faculty members working toward continued improvement.

In July 1968, AAAS held a Conference on Science in Technical Education. The report of the conference, Technical Education: A Growing Challenge in American Higher Education was published in 1968. Later that year, in cooperation with the American Association for Junior Colleges and the American Technical Education Association, AAAS held a symposium on the improvement of the science and mathematics content of technical education programs. The report of the symposium, Science Education as It Relates to Technical Education, was published in 1969.

For the past three years the AAAS Office of Education has held a program of short courses for college teachers of natural and social sciences and mathematics. The program has emphasized interdisciplinary topics such as: Biosociology; Political Socialization Applied to College Teaching; Water Pollution; Energy Problems; Demand, Supply, Environmental Costs and Political Decisions; and Nutrition in American Life. The primary objective of the short course program is to make available to college teachers as quickly as possible, new knowledge about topics of current interest in such a way that the materials will immediately be useful in college teaching. The courses are conducted by leading scholars at twelve field centers, four in each of three circuits -- eastern, central and western. In 1973-74 seven courses are being given in each of the eastern centers and eight in the central and western centers. Each course director tours his circuit in October or November, spending two days at each center with the course participants. Then in February or March he again tours the circuit and discusses with course participants the projects they have worked on during the interim period. Course directors are selected by AAAS. Approximately 30 participants are selected for each course by the field center coordinators.

In 1973 AAAS started a scholar exchange program with the Znaniye (Knowledge) society in the Soviet Union. Four American scientists went to the U.S.S.R. in 1973 and lectured to university faculties and other groups. Two Soviet scientists came to the United States and lectured to faculty and students at the University of Maryland, the Massachusetts Institute of Technology, The University of Massachusetts, and SUNY, Albany. The exchange program is continuing in 1974.

All of the activities described in this report were carried out with funds provided by the National Science Foundation.

revised, March 1974

Psychology

PROJECT TITLE: ANALYSES OF UNDERGRADUATE PSYCHOLOGY PROGRAMS

PROJECT DIRECTOR: C. Alan Boneau

PROJECT ADDRESS: American Psychological Association
1200 17th Street, N.W.
Washington, D.C. 20036

PURPOSE:
To get an accurate picture of undergraduate education in psychology and in particular to determine what innovative departures have occurred in the field.

AUDIENCE:
Psychology Department faculty members, Deans and other administrative personnel, students and the public at large.

INNOVATION:
Not particularly innovative or different. "Improving Undergraduate Curricula in Psychology" in 1952 and "Undergraduate Curricula in Psychology" in 1961 were forerunners of this survey.

EVALUATION:
The materials have been reviewed by a panel of outstanding educators in Psychology with an eye toward the implications of the survey.

MATERIALS:
Book: Undergraduate Education in Psychology, available from the American Psychological Association, 1200 17th Street, N.W., Washington, D.C. 20036.

PROBLEMS:
The only difficulty was a printing delay. Otherwise the project was executed with a minimum amount of difficulty.

Multidisciplinary

AGENCY: Fund for the Improvement of Postsecondary Education
Department of Health, Education, and Welfare
Washington, D.C.

Established by the Education Amendments Act of 1972, the Fund seeks to encourage reform, improvement and innovation in postsecondary education. The Fund is located, along with the Office of Education and the National Institute of Education, in the Department of H.E.W. under the general supervision of the Assistant Secretary of Education.

The Director of the Fund is Virginia B. Smith, formerly Associate Director of the Carnegie Commission on Higher Education. The Director and staff of the Fund are responsive to a fifteen-member, Secretarially-appointed Board of Advisors of educational and public interest representatives, who assist in the determination of funding priorities and in the review of proposals.

The Fund provides assistance to postsecondary educational institutions and agencies, including not only colleges and universities but also private trade, technical and business schools; counseling, referral, and testing agencies; professional associations; state educational agencies, and new as well as established educational institutions, student organizations and other educational agencies.

Directions of improvement encouraged by the Fund include: better and more informed choices by learners seeking postsecondary educational opportunities; more effective and coordinated use of libraries, museums, workplaces, and other resources as educational institutions; new educational structures demonstrating effective approaches toward non-traditional students; more vital, responsive, and purposeful educational institutions; more determined efforts to define educational goals in terms of competencies to be learned, and to credential students for mastery of these competencies, however they were acquired.

In fiscal year 1973, the first year of operation, the Fund made eighty-nine awards from among more than 1,400 applications. The size of these awards varied from $4,000 to a two-year award of $750,000.

This year, fiscal 1974, the Fund will run a comprehensive competition, soliciting bold and imaginative proposals for any or all areas of improvement, and special-focus competitions in particularly defined areas. For the comprehensive competition, a pre-application statement must be submitted to the Fund on or before December 15, 1973. The Fund will then invite a certain number of these applicants to submit full proposals on or before March 15, 1974. For the special focus competitions, there will be no pre-application process, and full proposals will be due on or before January 15, 1974.

Guidelines containing program information and application procedures for fiscal year 1974 awards may be obtained by writing the Fund, Department of H.E.W., 400 Maryland Ave. SW, Room 3139 - FOB-6, Washington, D.C. 20202.

Multidisciplinary

ASSOCIATION: Joint Council on Educational Telecommunications
1126 Sixteenth Street, N.W.
Washington, D.C. 20036

The Joint Council on Educational Telecommunications is a consortium whose membership now includes more than 20 of the nation's leading nonprofit organizations in education and communications. The JCET was originally established in 1950 to provide leadership in persuading the Federal Communications Commission to reserve television channels for noncommercial broadcasting. Without timely action at that critical juncture, the development of ETV and the creation of a national network for Public Television would have been forever lost.

The JCET serves in the arena of communications policymaking as education's established instrument for coordination and participation. During the past year, the JCET called the attention of the educational and public broadcasting community to the pressing need to modify the American Government's proposed position for the coming World Administrative Radio Conference on Space Telecommunications. Once again, timely effort preserved education's future options, and the U.S. Proposals now urge the reservation of the 2500 MHz band in space for educational communications satellites. The JCET has been equally active in seeking to assure education's access to channels on cable television systems.

The national organizations which are JCET's Constituent Members are: American Association for Higher Education, American Association of Junior Colleges, American Association of School Administrators, American Council on Education, Association for Educational Communications and Technology, American Library Association, Corporation for Public Broadcasting, Council of Chief State School Officers, Institute for Development of Educational Activities (I/D/E/A), Interuniversity Communications Council (EDUCOM), Great Plains National ITV Library, National Association of Educational Broadcasters, National Association of State Universities and Land-Grant Colleges, National Catholic Educational Association, National Education Association, National Educational Television, National Instructional TV Center, National Public Radio, and Public Broadcasting Service.

Associate Membership is open to nonprofit organizations of less-than-national scope: Alaska Educational Broadcasting Commission, Hawaii ETV Network, Indiana Higher Education Telecommunications System, Pennsylvania Public TV Network, Southern Educational Communications Association, and Western Educational Society for Telecommunications.

The Joint Council on Educational Telecommunications is supported by its members and by the Ford Foundation. In recent years, additional project support has come from the Kettering Foundation, the National Cable Television Association, and the Johnson Foundation.

The Joint Council's officers are elected annually from among the organizations' representatives who make up the JCET Board. The current officers are: President: Dr. William J. Ellena, Deputy Executive Secretary, American Association of School Administrators; Vice President: William G. Harley, President, National Association of Educational Broadcasters; Treasurer: Dr. Howard Hitchens, Executive Secretary, Association for Educational Communications and Technology. Frank W. Norwood is Executive Secretary of the Joint Council.

PROJECT TITLE: POLITICAL SCIENCE EDUCATION PROJECT

PROJECT DIRECTOR: Mark F. Ferber and Sheilah R. Koeppen

PROJECT ADDRESS: American Political Science Association
1527 New Hampshire Avenue, N.W.
Washington, D.C. 20036

PURPOSE:

The purpose of the project, simply stated, is to seek the improvement of political science education. While our primary focus has been on undergraduate education, our purpose has dictated a growing involvement with both pre-collegiate and graduate education.

We are concerned particularly with education that develops analytical skills. To this end we emphasize instructional developments for teaching such skills in subjects on politics, government and public policy, and for the use of educational technologies in teaching and learning these skills. We believe that this program requires us to provide incentives and institutions for the development, evaluation, and distribution of curriculum materials and information on alternative methods of teaching. The vast majority of political scientists are teachers and prospective teachers in colleges and universities. We want to assure that their activities as educators receive extensive support, are communicated widely, and are recognized by a professional reward system in a manner and degree comparable to that accorded research activities.

Critical to the long range success of the project is the institutionalization of this concern with teaching and curriculum development so that structures supported initially by the grant will continue to function after its expiration date.

AUDIENCE:

Political science teachers and graduate students who will be teachers are the primary audience for our projects. The initial activities of the Program involve mobilizing faculty interest and efforts, and establishing information networks to facilitate the development and evaluation of instructional materials and alternative methods of teaching. Graduate students are also addressed directly through a project to develop formats for teacher preparation in graduate programs of political science.

We intend to develop channels for the evaluation and distribution of course materials and, thus, ultimately our audience will be students. The student clientele for the instructional materials will be those in two-year and four-year college programs but, as the materials prepared are refereed, distributed, evaluated, and improved upon, we expect that special learning packages and programs will be developed for other student clientele, e.g., adult continuing education.

Pre-collegiate students are not the audience for the course materials, but are involved in the Program to the extent that their learning experiences will be secured so that decisions about instructional improvement in higher education are made with these experiences in mind.

INNOVATION:

The terms of the Grant establishing the Program, calls for the establishment of a Division of Educational Affairs within the American Political Science Association. The Division has a mandate to structure the strategy and mechanisms for improving education. Our work now to establish processes for reviewing, distributing, evaluating course materials represents an innovation for our professional association. Our selection of the methods for distributing these materials and for establishing the information networks that are identified usually with a discipline's education programs may represent another innovation. Our "tabloid" DEA NEWS is a form of publication that allows us to reach large numbers of political science teachers inexpensively and will allow us to distribute specific information about instructional methods and design. (We shall provide a memorandum about this form of publication and dissemination of information at the project directors meeting.)

EVALUATION:

Our activities for evaluation involve evaluation of: 1) DEA, 2) the structures established to provide incentives and information about instructional improvement, 3) the instructional materials that will be distributed. DEA is subject to review and oversight by the Steering Committee on Undergraduate Education and the Executive Director of the Association. The Committee on Educational Policy Planning and Review is preparing processes to evaluate education projects and their implementation for the Association that will be applied to our information systems and the processes for refereeing and reviewing the instructional materials.

The evaluation processes on education programs will include methods for obtaining systematic feedback from teachers and students: i.e., special intensive sample surveys of political science teachers to determine response to and use of the information networks and course materials and a format for acquiring evaluation of learning achievement from course materials and featuring the evaluations in the distribution of course materials.

MATERIALS:

DEA NEWS for Teachers of Political Science, a tabloid on issues and methods in political science education at all levels, is the newsletter supported by the Grant. The first issue has been mailed to all Association members, chairmen of all two- and four-year college departments offering political science, and to others requesting it of our office.

The reports of the Task Force on Audio-Visual Instruction in Political Science and of the Task Force on Computer Related Instruction in Political Science have been completed and will be distributed to all political science teachers.

A series of instructional resource monographs that are guides to methods of organizing courses and political science materials, is being initiated. And, as a result of the Task Force reports, there will be a series of evaluative guides to instructional materials accessing these educational technologies. Provisions are made for periodic reviews to keep the guides up to date. These materials will be available from DEA, probably at nominal fee, to non-members.

In conjunction with the Association's Departmental Services, a series of bulletins for students are being prepared on Career Opportunities and the Study of Political Science and Internship and Field Work Programs. Bulletins for faculty and students on Grant Opportunities (for educational development and research, particularly involving undergraduate participation) will be forthcoming this winter. These bulletins will be distributed to all member departments free of charge.

PROBLEMS:

Viewed from the perspective of one year, the most significant problem has been the need to develop a coherent strategy for accomplishing the broadly defined goals delineated in the original proposal. These goals accurately reflect thinking within the profession but it has taken time to focus upon specific functional categories of activities that address themselves directly to particular problems or segments of problems. Whether this problem is endemic to projects of this scope--particularly in a discipline as pluralistic in approaches, methodologies, and educational foci as is political science--remains unknown, but there has been a natural progression from broadly agreed upon activities to more narrowly defined, discrete activities that respond to these problems.

The lessons of this first year, would suggest concentrating resources, at the outset, on a relatively limited number of high priority, discrete projects, and the importance of identifying existing, or creating new, organizational networks for implementation of these activities.

ASSOCIATION: The Mathematical Association of America
1225 Connecticut Avenue, N.W.
Washington, D.C. 20036

REPORTER: Alfred B. Willcox

Since I am not the project director of any NSF-supported activity, but the Executive Director of an Association that is the frequent recipient of NSF support for projects in science education, I will not report in detail on present project activity. Instead, I will report very briefly on present NSF-supported projects and on some of our new project plans.

The Mathematical Association of America is presently engaged in three NSF-supported projects:

1. A project to produce a source book for college mathematics students and faculty on applications of undergraduate mathematics in the social sciences.

2. A project to prepare case studies and resource materials for advanced undergraduate mathematics. These materials will help provide students experiences closely approximating the actual work of a mathematician working in an applied field.

3. A project to prepare a Source Book on Applications of Mathematics to a Variety of Disciplines designed to help secondary school teachers introduce more varied and more realistic applications into their courses. Applications from other disciplines as well as from everyday life will be introduced. Particular attention will be paid to the role of model building in studying real world situations.

Several new projects are in various stages of planning. Decisions about submission of proposals have not yet been made, but it is assumed that some of these proposed projects will be presented to the NSF for possible funding. Among these projects are:

1. A project in continuing education of scientists and engineers based on the use of mathematical models as teaching devices.

2. A project to produce pilot films for a possible series of Educational TV programs aimed at a general audience. The object is to show that films can be made to appeal to a general audience showing how mathematicians and scientists from other disciplines work together on problems of societal importance. Both the subject matter and the expository techniques are important in this project, which will make extensive use of consultants from educational TV.

3. A project in continuing education for adults who, for reasons of weak high school training or long separation from the ideas and techniques of the subject, do not feel "at home" with mathematics.

The program would be designed for an "open university" and would be designed to provide the minimum familiarity with mathematics necessary for survival in a technological age. It would also provide a base for future career oriented training in specific areas of mathematics.

4. A project for a series of workshops to bring mathematics faculty and students together with representatives of industry for periods of up to one week. The object would be a free discussion of problems arising in industrial R & D work leading to an increased awareness of the role of mathematics in an R & D environment and also, possibly, to some new research and teaching insights in American colleges and universities.

5. A project to prepare source books on applications of undergraduate mathematics in the life sciences and in management science.

6. A project to initiate a new national competition for college students based on the construction of mathematical models and formulation of mathematical problems which will contribute to the resolution of real life problems arising in industry, business and science.

Multidisciplinary

PROJECT TITLE: TWO-SEMESTER GRADUATE SEQUENCE IN TRANSPORTATION ENGINEERING

PROJECT DIRECTOR: Joseph V. Foa

PROJECT ADDRESS: The George Washington University
Washington, D.C. 20006

PURPOSE:

The objective of the workshop is to acquaint the student with the increasingly complex problems of transportation and particularly of urban transportation and to stimulate in him the kind of thinking that is required for a creative and realistic approach to their solution.

AUDIENCE:

The first part of the course is a seminar-workshop in which students of various engineering and nonengineering disciplines (including social and political sciences, economics, and urban and regional planning) are brought together for a joint study of the land-use objectives and transportation needs of a selected urban area, and for a survey of pertinent information and applicable solutions. The second part of the sequence is a team engineering project in which the knowledge acquired in the first semester is collectively utilized in something approaching a preliminary design of a transportation system for the selected geographic area.

INNOVATION:

Two aspects of the project are particularly novel and noteworthy:

(1) Each student is required to choose a pertinent aspect of the problem within his field of competence, to study it in depth, and to participate in the capacity of a "specialist" in his chosen subject in weekly conferences with his fellow students and with the teaching staff in the course.

(2) The teaching staff is multidisciplinary. At present, it comprises faculty members with special competence in "hard" engineering (mechanical and civil), operations research, command and control, transportation planning, and urban and regional planning.

EVALUATION:

The project is subjected to continuing evaluation by participating staff and students, and has already undergone radical changes since its first run.

MATERIALS:

(1) At the end of each project the most significant term papers written by the participating students are collected in a volume for distribution to governmental agencies, planning commissions, and other interested organizations in the urban region considered in the study, and to interested individuals or groups anywhere. So far, three volumes have been published and distributed in this manner, one on transportation in Arlington County, Virginia, one on access to Dulles Airport, and one on transportation in Washington, D.C. The last two volumes are also available through the National Technical Information Service (5285 Port Royal Road, Springfield, Virginia 22151), as documents PB 220 074 and PB 226 829/AS, respectively.

(2) A detailed account of the development of the workshop, of the difficulties encountered, and of its final structure and operation will be issued at the end of the project.

PROBLEMS:

(1) Timing and sequencing of invited talks by outside speakers so as to produce the greatest possible benefit to the project team,

(2) delays caused by student uncertainties in their individual choice of a study area, and, above all,

(3) the difficulty of maintaining uniformly high standards in all aspects of a multidisciplinary effort.

Information/Computer Science

PROJECT TITLE: AUDIOGRAPHIC LEARNING TECHNOLOGY IN CONTINUING SCIENCE INFORMATION

PROJECT DIRECTOR: Vladimir Slamecka

PROJECT ADDRESS: School of Information and Computer Science
Georgia Institute of Technology
Atlanta, Georgia 30332

PURPOSE:

The aim of this project is to demonstrate the potential of a low-cost self-instruction system that uses a minicomputer to guide a learner's access to an electronically stored, centrally located lesson base of audiographic learning materials (synchronized voice and line-graphics recordings). The system has been designed to operate within the low bandwidth of ordinary telephone lines; to allow the learner control over his learning strategies; and to provide the educator with a very economical method for preparing and updating learning materials.

AUDIENCE:

The specific target audience of the present project are State employees participating in a program of continuing science education at the graduate level. In other projects, the potential of audiographic technology has been shown in experiments at all educational levels--primary, secondary, vocational, and undergraduate.

INNOVATION:

The system is characterized by low costs of equipment, operation, and preparation and maintenance of learning materials, and by versatility. It can be used day or night, and learning stations can be established wherever telephones can be installed. By providing the learner with simple command options, the system allows him to participate actively in his own learning process: having called the lesson of his choice, he can at any time take any of the following actions: stop the lesson and restart it after pausing; browse backwards or forwards within the lesson; repeat the lesson; skip to a self-test portion of the lesson; request an example of the concept explicated in the lesson; call for a related lesson; etc.

EVALUATION:

The evaluation plan calls for comparison between two groups of learners, one of which has used the system with the additional aid of an on-site human tutor, the other of which has not. The results will perhaps be suggestive of the proper role which human tutors should occupy as interfaces for and managers of learning systems of the future.

MATERIALS:

The project will produce a collection of audiographic recordings on topics in systems theory, computer software systems, computer systems management, and data base design and management.

Civil Engineering

PROJECT TITLE: TRAINING AIDS IN TRAFFIC-SIGNAL ENGINEERING

PROJECT DIRECTOR: Peter S. Parsonson

PROJECT ADDRESS: Georgia Institute of Technology
Atlanta, Georgia 30332

PURPOSE:

The objective of the project is to develop a series of three motion-picture films (16 mm) on the timing of actuated traffic signals at local intersections. The availability of the films will be publicized by Georgia Tech, and they will be loaned free of charge to graduate-level traffic engineering programs that request them.

AUDIENCE:

The potential viewing audience in any one year is estimated to be approximately 500 Master's degree candidates enrolled in Schools or Departments of Civil Engineering, plus several hundred graduate engineers who would view the films at short courses offered by universities or governmental agencies.

INNOVATION:

No such films exist at present, and it is well known that they are needed.

EVALUATION:

Georgia Tech will offer to supply with each film an examination and its solution, for use by the borrowing university or agency in evaluating the effectiveness of the film.

MATERIALS:

The films will present the exercises used at the Georgia Tech Traffic Signal Laboratory and will include scenes of the Atlanta intersections on which the exercises are based. Difficult timing concepts will be explained with the aid of animated graphs.

PROBLEMS:

The most serious difficulty has been the conversion of lecture material into a film script. It requires close cooperation between the professor and the cinematographer.

Chemistry

PROJECT TITLE: COMPUTER-BASED TEACHING OF CHEMISTRY

PROJECT DIRECTOR: Stanley Smith

PROJECT ADDRESS: Department of Chemistry
University of Illinois
Urbana, Illinois 61801

PURPOSE:

This research is directed toward improving the quality of the teaching of chemistry at the college and university level by providing interactive, individualized instruction on the PLATO IV computer-based teaching system. The graphic capabilities and computational power of PLATO IV make it possible to include the study of chemical phenomenon through simulated experiments as an important component of the instruction.

AUDIENCE:

The computer-based teaching programs are directed toward first and second year college level chemistry students. At present, they are being used on an experimental basis at three universities and two community colleges. During the Fall Semester, 1973, the programs were used more than 6,000 times.

INNOVATION:

The program provides immediate individual feedback from the instructor to each student. Lessons are designed to insure that a student attains an acceptable level of understanding before moving on to new material. The powerful graphical capabilities of the system, and the ability to combine a tutorial dialogue between student and instructor with sophisticated mathematical models of chemical systems, allows the exploration of a wide range of teaching techniques which are not possible in conventional classrooms.

EVALUATION:

On line data collecting techniques have been developed which, with appropriate computer processing, provide the instructor with immediate diagnostic information on the level and effectiveness of the teaching material. These data form the basis for subsequent improvement in the programs.

MATERIAL:

All materials exist as programs available through any PLATO IV terminal.

PROBLEMS:

The use of on-line evaluation techniques and the ease of modification of lesson materials make it possible to continually revise and improve the programs. As a result, each lesson is the result of an evolutionary process rather than a well defined set of iterations.

Engineering
Interdisciplinary

PROJECT TITLE: EDUCATION AND EXPERIENCE IN ENGINEERING (E^3)

PROJECT DIRECTOR: T. Paul Torda

PROJECT ADDRESS: Illinois Institute of Technology
Chicago, Illinois 60616

PURPOSE:

Development of an undergraduate program for education of engineers to high level of interdisciplinary competence so that they may be able to solve problems within technological, social, economic, legal, etc., constraints. Also, achievement of proper motivation for students to obtain this high educational level.

During the four years of education, emphasis is placed on non-technical factors involved in engineering solutions without "dilution" of the quality and content of technological education: The humanities and social sciences are integrated into the new curriculum. The problem solving process is used throughout the four years of undergraduate education and, through use of small work groups formed by students from the four years, apprentice-tutorial relationship is developed between students and faculty. Self-paced instruction is used for learning of the material needed to solve the problems at a high level of sophistication.

AUDIENCE:

The program is addressed to undergraduate engineering students from freshmen through seniors. However, the philosophy and methodology are applicable to all fields of professional education. Presently, the program is in the second year of implementation having mostly sophomores and freshmen as participants (with a few junior transfer students from other universities or programs).

INNOVATION:

Integration of tried and proven philosophy and methodology into a unified program. Novel use of self-paced instructional material as well as student evaluation in a new form which is appropriate to the education of self-initiating, self-pacing and self-evaluating professional engineers.

EVALUATION:

Formal external evaluation is used for the program as well as student progress.

MATERIALS:

Formal material for project proposal and reporting, as well as procedures for evaluating these have been developed. Learning Modules for self-paced instruction have been developed based on common-core as well as professional courses. These are available to interested faculty on a trial basis.

PROBLEMS:

The most serious problems encountered are budgetary. Due to these constraints, faculty as well as administrating personnel is overloaded. Naturally, there are problems encountered, as is the case in development of experimental programs, but these are within the bounds of original expectations.

ADDITIONAL COMMENTS:

Inclusion of computer aided and computer managed instruction, use of communication media (film, closed circuit television, graphic arts, etc.), development of material generated into exportable "packages," training of faculty other than immediate participants, etc., is planned during the last two years of implementation.

Mathematics
Mathematics Education
Psychology of Mathematics Education

PROJECT TITLE: SURVEY OF RECENT EAST EUROPEAN LITERATURE IN SCHOOL AND COLLEGE MATHEMATICS

PROJECT DIRECTOR: Izaak Wirszup

PROJECT ADDRESS: Department of Mathematics
The University of Chicago
Chicago, Illinois 60637

PURPOSE:

The Survey of Recent East European Literature in School and College Mathematics was established in 1956 in the Department of Mathematics at the University of Chicago to answer an urgent need for information and materials in mathematics and mathematics education from East European sources. Its main objectives have been: (1) to study current developments in teaching mathematics and related subjects at all levels in the Soviet Union and other Communist countries, (2) to make accessible these studies and other relevant information to projects for improving mathematics education in the United States and to the mathematical community, and (3) to publish for U.S. teachers and students some of the best materials from these sources.

AUDIENCE:

Following the objectives delineated above, the SURVEY has concentrated on (a) the Soviet programs in extracurricular mathematical activities, (b) the literature prepared by outstanding mathematicians for mathematically talented students, (c) the training and improvement programs for mathematics teachers, and (d) the research conducted over the past 30 years by Soviet psychologists and mathematicians in the psychology and methods of learning and teaching mathematics.

The first three SURVEY programs resulted in some 33 books translated and adapted for American high school and college students and their teachers. These books were published by well-known publishers, and have been widely acclaimed and incorporated in high school and college libraries throughout the country.

Program (d) was conducted as a joint effort by the SURVEY and the School Mathematics Study Group (SMSG) of Stanford University and resulted in the preparation of a 15-volume series of SURVEY translations and adaptations entitled, Soviet Studies in the Psychology of Learning and Teaching Mathematics. The six volumes now published in this series are being studied in seminars and courses at many colleges and universities across the United States. Ideas contained in the volumes have also inspired research and doctoral dissertations at such institutions as Columbia University and the University of Wisconsin Research and Development Center for Cognitive Learning. The publisher and the SURVEY have also had many requests from Europe for the six published volumes. The

remaining 9 volumes of the Soviet Studies series are currently being edited by the entire staff of the University of Georgia's Department of Mathematics Education, which volunteered to do so.

The SURVEY's Director, Izaak Wirszup, has been engaged in numerous studies of mathematics education in the Soviet Union, Poland and other Communist countries. He has delivered over 80 invited addresses and lectures on various topics relating to the SURVEY at national and regional meetings of mathematicians and educators, at NSF Institutes, and in Departments of Mathematics throughout the country. He has also published eight papers relating to his SURVEY studies in The American Mathematical Monthly and in The Mathematics Teacher, and has co-authored sixteen other mathematical papers based on SURVEY materials.

INNOVATION:

The SURVEY is the only organized project in the United States designed to study foreign mathematics education. Over the years it has accumulated, organized and catalogued a unique library of some 11,000 volumes from Eastern Europe in mathematics, its applications, mathematics education, science, science education, educational psychology and the education of the handicapped. This library is unexcelled in the United States in its collections of elementary- and secondary-school textbooks; of monographs and texts for use in universities, pedagogical institutes, technical institutes and various other professional schools; of literature in the psychology and methods of learning and teaching mathematics and science; of reference books; and of serial publications for extracurricular programs in mathematics. The SURVEY's collection is complemented by subscriptions to more than 30 Russian, Polish, German and other journals in the areas of special interest to its programs. The SURVEY also has informal agreements for the exchange of publication materials with the U.S.S.R. Academy of Pedagogical Sciences.

EVALUATION:

The publication of SURVEY translations and adaptations by such prestigious companies and institutions as The University of Chicago Press, the M.I.T. Press, Academic Press, Pergamon Press, and D.C. Heath and Company is itself a very strong indicator of the worth of this project. Other positive indices of the value of SURVEY publications are the facts that they are being used in high school and college libraries throughout the United States, and that published SURVEY translations are themselves being translated into other languages by such countries as Italy, Brazil, Spain and Canada (French).

MATERIALS:

SURVEY publications now in print include: the series Topics in Mathematics (15 books from the Russian series, Popular Lectures in Mathematics) and 6 larger mathematical volumes (Please see the attached list of SURVEY Publications) published by D. C. Heath and Company, Lexington, Massachusetts; 4 mathematical volumes, published by Pergamon Press, Oxford - New York; Geometric Transformations (2 volumes) by Modenov and Parkhomenko, published by Academic Press, New York; Challenging Mathematical Problems with Elementary Solutions (2 volumes) by Yaglom and Yaglom, published by Holden-Day, San Francisco. The M.I.T.

Press, Cambridge, has published three volumes of a series of SURVEY translations entitled the Library of School Mathematics: Vol. 1, The Method of Coordinates; Vol. II, Functions and Graphs; and Vol. III, Sequences, Combinations, Limits. A SURVEY translation and adaptation of Geometry by Kutuzov was published by the School Mathematics Study Group (as Volume IV of its Studies in Mathematics).

SURVEY translations and adaptations of 10 additional Popular Lectures in Mathematics are under contract for publication by The University of Chicago Press. Of these, six are currently in press.

Also in print are the first 6 volumes of the 15-volume series, Soviet Studies in the Psychology of Learning and Teaching Mathematics. The aim of this series is to acquaint U.S. mathematics educators and educational psychologists with directions, ideas, and accomplishments in the psychology of mathematical instruction in the Soviet Union and to assist in opening up avenues of investigation to those interested in the improvement of the teaching of mathematics in the United States.

Geography

PROJECT TITLE: TEACHER DEVELOPMENT IN PH.D. PROGRAMS IN GEOGRAPHY

PROJECT DIRECTOR: William D. Pattison

PROJECT ADDRESS: Department of Geography
University of Chicago
Chicago, Illinois 60637

PURPOSE:

This profession-wide project has been organized to foster an alternative philosophy of education among doctoral programs in geography in the United States. Challenging the generally accepted view that training for disciplinary command is sufficient for such programs, the project sponsors local pilot ventures in which a practice-oriented approach to problems of teaching becomes part of the preparation for the Ph.D. degree.

AUDIENCE:

National: Our targets are all fifty-three doctoral departments of geography in the United States.

INNOVATION:

(1) Extension of educational reform (hitherto restricted to undergraduate and pre-collegiate institutions) into graduate departments.

(2) Adoption of the following strategy: sponsorship of five locally originated programs for teaching-role preparation of doctoral students.

(3) Through this strategy, promotion among professors and prospective professors of (a) systematic thinking about teaching, and (b) valuing of students as sources of information, inspiration, and initiative.

(4) Assumption of responsibility by a national association representing an entire discipline.

EVALUATION:

Project evaluation is to proceed at two levels, national and local.

(1) National evaluation is to be based upon the following intended outcomes:
    (a) an improved population of teachers at college and graduate levels,
    (b) an array of developmentally conceived, self-sustaining programs in the teaching/learning arts for doctoral students,

(c) a communications network linking geographers skilled in preparing others in the teaching/learning arts, and
(d) the development of principled knowledge germane to the preparation of teachers of higher education.

(2) Local evaluation is to be based upon outcomes declared by the respective on-site directors.

MATERIALS:

The project is not primarily materials-oriented. Our products, as reflected in the outcomes specified above, are improved practices and qualified persons.

PROBLEMS:

We have encountered--principally--two related but distinct difficulties:

(1) Finding the means for inducing a department-wide willingness to experiment with a learning model of education (as an alternative to the accustomed content model).

(2) Securing the departmental commitment required for the institutionalization of the training programs we are sponsoring.

Multidisciplinary

PROJECT TITLE: THE UICC DOCTOR OF ARTS DEGREE: RESEARCH IN COMMUNICATING KNOWLEDGE

PROJECT DIRECTOR: James L. Norr

PROJECT ADDRESS: Graduate College
University of Illinois at Chicago Circle
Chicago, Illinois 60680

PURPOSE:

This new alternative doctoral degree program has the following major goals:

1. To improve the quality, scope, and effectiveness of science instruction - especially undergraduate instruction and teaching - through new doctoral work.

2. To utilize educational technology to promote the design of new instructional systems and to assure an adequate supply of quality materials for technologically based educational systems.

3. To generate a body of principles related to the communication of knowledge, teaching, instruction, curriculum development and media utilization.

AUDIENCE:

The University of Illinois at Chicago Circle has developed a Doctor of Arts program in response to a perceived need for a new point in the spectrum of talent in the field of science instruction. The D.A. will be educated to carry out research in communicating knowledge from a strong foundation of knowledge in a discipline.

INNOVATION:

At present, Doctor of Arts degrees are being offered by the Chemistry Department and the Mathematics Department. The Physics Department should be offering the new degree by next quarter, and the Biology Department has an excellent plan for the degree. The disciplinary department is the source of the proposal and the home of the candidate. A Doctor of Arts staff offers extra-departmental courses in the psychosocial aspects of higher education, instructional design, educational technology, and experimental design in natural instructional settings. In addition to these courses, the degree has a structured supervised internship, and coursework which matches the Ph.D. in amount but which allows greater breadth. Hopefully the internship will be carried out in an outside institution of the kind in which the candidate intends to work after obtaining his degree.

The thesis normally involves the preparation of an instructional unit directed by Faculty members from the department and from the D.A. staff. This unit will be tested for effectiveness and will explore some important question in science education. It is in this last effort that the candidate will be oriented toward research in communicating knowledge.

The D.A. is not intended to replace either the Ph.D., the Ed.D., or the Ph.D. in Education. Rather, the intention is to have individuals with advanced preparation in the substance of a discipline who are concerned with exploring the problem of communication of the knowledge of the discipline to other people who need it. Thus, while they will not have the orientation of research at the forefront of the discipline and will not have the in-depth preparation for disciplinary research, they will have practical experience in the elements of the instructional process and in the use of educational technology; they will have been introduced to knowledge of the social and behavioral sciences which underly the communication and learning process. Most important, they will have been taught the elements of research in science teaching.

EVALUATION:

Documentation and evaluation plans cause the project to be the subject of the observations and analysis of scholars from different disciplines and different perspectives such as sociology, psychology, anthropology, engineering, and economics, as well as for the project science disciplines. A full range of attitudes are included in the observers--friendly, hostile, skeptical, curious, etc. Different levels of commitment and self-interest will be clearly identified. Students, professors, parents, employers, are all having their opinions and observations included in the record. Different techniques of data collection--open-ended essays, Likert scale instruments, oral interviews, projective tests, etc.--will be used. Different time scales will be sampled. Observations are being made during, before, immediately after and long after project events. As the project unfolds, shifts in emphasis in examining the system will undoubtedly take place. These will be determined by trying to answer the most challenging questions which can be asked and the availability of techniques which (within resources) offer the hope of the most clear-cut answer.

MATERIALS:

At this point the following materials have been developed:

PLATO IV Computer Assisted Instruction Programs in German, biology, statistics, economics, sociology, mathematics, chemistry, art, and engineering using the graphic capability of PLATO IV terminals.

Film and vido tape: Animation Computer Graphics for use in education, preparation of cassette video tape courses and self paced instruction using audio-tutorial materials in chemistry, psychology and biology.

Additional information can be obtained by writing the project coordinator.

PROBLEMS:

The major difficulty in implementing the project is gaining legitimacy for our concept of the D.A. On one level is the problem of accepting the idea of the need for a new degree which differs from the Ph.D. Another version of this problem is convincing science departments that knowledge of psycho-social aspects of higher education, instructional design, educational technology, and experimental design in natural instructional settings is important enough to give up some discipline course work.

Environmental Policy,
Management and Education

PROJECT TITLE: CURRICULUM DEVELOPMENT IN THE STUDY OF THE INTERACTION OF SCIENCE AND SOCIETY

PROJECT DIRECTOR: Lynton K. Caldwell

ASSISTANT DIRECTORS: Lynton R. Hayes and Isabel M. MacWhirter (previously other Assistant Directors)

PROJECT ADDRESS: Public and Environmental Affairs
Indiana University
Bloomington, Indiana 47401

PURPOSE:
(1) to improve communications and understanding of the meaning of science in society and (2) to provide models, guidelines and materials to other universities.

AUDIENCE:
Addressed to teachers at upper high school level and university; to community action leaders; to senior high school students and undergraduate students; public officials and all others interested in science and public policy.

INNOVATION:
Unique characteristics include emphases on systems theory, value analysis, a study guide approach and case studies which link the empirical and theoretical.

EVALUATION:
Various sections of the Study Guide have been reviewed by experts in the respective fields. Further evaluation will occur from users upon publication. Field testing is an integral part of the project. The materials of Volume II (revised) and Volume III will be evaluated in phases; selected student groups, discussed in teacher forums, assessed in graduate curriculum development seminars, trial usage in courses at Indiana University.

MATERIALS:
Volume I. Science, Technology and Public Policy: A Guide to Advanced Study.
Volume II (revised). Science and Social Evolution: A Guide to Advanced Study.
Units of Volume II have been drafted. Preliminary models only at this stage. The materials will be available in the summer of 1974. Units include:

Land Use
Energy

Coastal Zone
Wildlife and Natural Areas
The Economy
Environmental Management and Institutional Arrangements
Quality of Urban Life

Volume III. Environmental Policy, Law and Administration.

The material is substantially completed and will be available in the summer of 1974. The contents include bibliographies and leading questions for study guides in the following sections:

I
Introduction and Background
Basic Environmental Concepts

II
Environment as a Policy Issue
Origin--Characteristics--Implications

01 Emergence of Environment as Public Issue
02 Systems Approach to Environmental Policies
03 Environmental Aspects of Resource Policies
04 Environmental Health and Human Habitation

III
Reconciling Natural and Technical Systems
Objectives--Approaches--Processes

05 Environmental Implications of Energy Systems
06 Atmospheric Systems and Air Quality Control
07 Hydraulic Systems and Water Quality Control
08 Ecosystem Management and Land Use Control

IV
Problems of Policy Implementation
Economic--Juridical--Institutional

09 Economic Aspects of Environmental Policies
10 Juridical Aspects of Environmental Policies
11 Administrative Organization and Procedures
12 International Institutions and Agreements

Biology

PROJECT TITLE: MINICOURSE DEVELOPMENT PROJECT

PROJECT DIRECTOR: S. N. Postlethwait

ASSOCIATE DIRECTOR: Norris Ross

PROJECT ADDRESS: Purdue University
Lafayette, Indiana 47907

PURPOSE:

To produce self-instructional materials (audio-tutorial format) for minicourses covering a "core" of biology.

AUDIENCE:

The "pool" of approximately 80 minicourses is primarily for college freshmen. Several have been used in field test trials and all should be available by Fall, 1975.

INNOVATION:

The minicourses are organized in twelve clusters focusing on specific areas of biology including: genetics, evolution, ecology, energy, reproduction, behavior, human biology, introduction to biology, growth and development, diversity/unity, cell physiology, and structure and function. A cluster of minicourses covering genetics, for example, may include 2 or 3 general minicourses, some in-depth ones, and some special interest or case study units. Conventional courses can be organized from minicourses taken from different clusters and arranged in various combinations to any desired content and length. The major feature of the audio-tutorial format and minicourse combination is the flexibility for individualization.

EVALUATION:

Formative evaluation involves a sequence of 15 steps requiring input and reaction from 9 instructors, 2 or more students, and 3 or more content experts. Other evaluation involves field testing in 6 or more colleges for approximately half of the minicourses developed.

MATERIALS:

The materials for each minicourse include: a student guide, an audio tape, projected items (2 x 2 slides and/or film) if any, special tangible items if any, and an instructor's manual. These materials should be available on or before Fall 1975. Negotiations with potential publishers are currently underway.

PROBLEMS:

The major problem was the involvement of too many part-time people as developers of materials. This resulted in a major time investment in their training and considerable inefficiency of production. In any new proposal I would hire only full-time staff for the primary development activities.

ADDITIONAL COMMENTS:

The impact of the project has been considerably greater than through materials produced only. For example, during the first semester of the 1973-74 school year alone, over 100 people have visited the Minicourse Development Project facilities at Purdue, including visitors from 14 states and 9 countries.

Physics

PROJECT TITLE: THE TECH PHYSICS PROJECT

PROJECT DIRECTOR: Philip DiLavore

PROJECT ADDRESS: Indiana State University
Terre Haute, Indiana 47809

PURPOSE:

The aim of the Tech Physics Project is to produce instructional materials for the teaching of introductory physics in a "modular" form, and with a laboratory-oriented approach. Each module comprises a relatively independent unit of instruction, and each is based upon a technological device or system. The students' investigations are centered about the system and, in each module, only those physics topics which flow naturally from the study of the device are discussed. Approximately ten to twelve modules will form a one-year course, but about twenty-five of them are being produced, so that the individual teachers will be able to assemble sets of modules which are most appropriate for their students. Insofar as possible, the Project encourages individualized study of modules.

AUDIENCE:

The group of students at which the Physics of Technology modules are aimed comprises those students who are in technician training or technology programs and who are taking a "technical physics" course. Thus far, the modules have been used widely by such students, but they have also had considerable use in other kinds of courses; e.g. those for liberal arts students, pre-professional students and even in a number of high schools.

INNOVATION:

Unusual aspects of the Physics of Technology modules include the following:

1. Physics is taught by means of "real-world" devices.

2. The instructional units are three-week modules, which may be assembled from a much larger set than could be used in a whole year; the intention is that the teacher then can use those modules which are most appropriate for his students.

3. "Coverage" of topics in a traditional sense is not aimed for. Rather, it is intended that the students should get into the topics they do cover in more depth and that this treatment shall give them a feel for the methods and topics of physics. However, most of the traditional topics are covered in some modules and teachers may choose which of those they wish to include by appropriate choices of modules.

4. Generalization into broad, physical principles follows from specific observations by the student of the particular principle in action in the device being studied.

EVALUATION:

Each of the four centers which are producing the Physics of Technology modules have been carrying on field tests. From the time the first draft is written, a module is tested in as many schools and with as many classes as possible; the results of these tests then provide information for the revision of the materials. In addition to this, some field testing emanating from the Project Coordinator's office has been carried on at a number of other colleges, and feedback from these is also important to the revision of the materials.

Presently the Project has under consideration by the National Science Foundation a proposal for the more extended and coordinated field testing of the materials in a number of colleges. It is hoped that it will be possible to try out full-year courses based completely on the Physics of Technology modules at about ten colleges.

Also under consideration by the National Science Foundation is a proposal from the Tech Physics Steering Committee for a formal evaluation of the Physics of Technology modules. This is to take place, if funded, after the completion of the materials.

MATERIALS:

Below is a list of Physics of Technology modules which are now available for preliminary classroom trials. Each may be ordered from the Production Center under which it is listed at the price of $2.00 per copy. Those modules which are starred (*) exist in a form which is being drastically revised, and will generally be available in classroom quantities. Doubly starred (**) modules should be available sometime during the Spring of 1974.

Permission to reproduce a module for a specific classroom trial may be obtained by writing to the Project Coordinator.

Florissant Valley Community College, St. Louis, Missouri 63135
--Professor Bill Aldridge

The Analytical Balance: A Module on Measurement, Errors, and Mechanical Equilibrium.
The Camera: A Module on Optics and Photographic Measurements.
*The Binoculars: A Module on Waves, Physical Optics, and Geometrical Optics.
*The Ignition System: A Module on Electricity and Magnetism.
*The Incandescent Lamp: A Module on Thermodynamics, Current Electricity, and Photometry.
**The Guitar: A Module on Wave Motion and Sound.
**The Laser: A Module on Modern Optics and Quantum Mechanics.

Oak Ridge Associated Universities, P.O. Box 117, Oak Ridge, Tennessee 37830
--Dr. Homer Wilkins

The Cloud Chamber: A Module on the Detection of Radiation and Phase Changes.
The Geiger Counter: A Module on Electrostatics and the Detection of Radioactivity.
**The Ionization Chamber: A Module on Electrostatics and the Detection of Radioactivity.
**The Fluorescent Lamp: A Module on Atomic Physics
**The Management of Nuclear Data: A Module on Measurement and Error.

Technical Education Research Centers, 575 Technology Square, Cambridge, Massachusetts 02139
--Dr. John McWane

The Power Transistor: A Module on Heat Transfer.
The Pressure Cooker: A Module on the Thermal Properties of Matter.
The Spectrophotometer II: A Module on the Spectral Properties of Light.
The Loudspeaker: A Module on Sound.
The Electric Fan: A Module on Rigid Body Rotation.
**The Strip-Chart Recorder: A Module on Mechanical Oscillations and Resonance.
**Photodetectors: A Module on the Interaction of Light and Matter.

State University of New York at Binghamton, Binghamton, New York 13901
--Dr. C. R. Stannard

The Toaster: A Module on Heat and Energy Transformations.
The Torque Wrench: A Module on Forces, Torques and Elasticity.
The Stroboscope: A Module on Motion
The Cathode Ray Tube: A Module on Electric Fields and Forces.
*Hydraulic Devices: A Module on Hydraulics and Equilibrium.
**Automobile Collisions: A Module on Momentum and Energy.
**The Transformer: A Module on Magnetic Properties of Matter and Alternating Currents.

PROBLEMS:

The Physics of Technology modules are being produced in four different Production Centers rather widely scattered around the country, with the coordination of these four centers being done at a central office. There is also a Steering Committee, which is responsible for setting the policies under which the Project will operate and for the quality of the finished product. In all, there are approximately fifty people working on the Project. With such a large number of people in such widely scattered locations working on the same project, the number one problem is communications. It is difficult to say how this problem might be solved in a similar project of this scope. Perhaps there is no easy solution.

An additional problem stems from the fact that the proposals for the project were originally for the development of modules. Now that some of the modules are in the production stage various problems have surfaced at the various centers concerning their printing and distribution. This is partially solved by National Science Foundation permission to sell modules at cost.

ADDITIONAL COMMENTS:

This Project is funded through five separate grants from the National Science Foundation, one to the Project Coordinator and the other four to the Production Centers. The Project Directors at each of the Production Centers are as follows:

Oak Ridge Associated Universities

Dr. L. K. Akers
Dr. John F. Yegge

Florissant Valley Community College

Professor Bill G. Aldridge

Technical Education Research Centers

Dr. John McWane

The State University of New York at Binghamton

Dr. C. R. Stannard
Dr. Bruce B. Marsh

The Physics of Technology modules will be published in final form in January, 1976, by the McGraw-Hill Book Company. The accompanying apparatus is to be manufactured by Thornton Associates; some of it is now available.

Physics

PROJECT TITLE: AN EXPANDED GRADUATE LABORATORY PROGRAM SERVING PHYSICS, OTHER TECHNICAL DISCIPLINES, AND REGIONAL INDUSTRY

PROJECT DIRECTOR: A. H. Clark

PROJECT ADDRESS: University of Maine at Orono
Orono, Maine 04473

PURPOSE:

The purpose of our program is to expand our graduate laboratory course to the point where it not only meets the needs of our own physics students, but also serves other scientists and engineers both on campus and in regional industry. Thus we hope to provide an efficient instructional mechanism for those who need to augment their technical skills because of the ever-increasing sophistication of modern measurement techniques and instrumentation.

AUDIENCE:

The program is addressed to the three groups mentioned above. Its use thus far has been predominantly by our own physics graduate students although a few industrialists and high school teachers have taken advantage of it. There are about 5000 technical people in the State of Maine who serve as a potential audience.

INNOVATION:

We have developed the course around a modular concept with a simplified continuing education division enrollment. Thus, the student selects precisely the amount of training that he or she requires (e.g. 4 weeks of gamma ray spectroscopy, 4 weeks of digital electronics, 8 weeks of cryogenics). The scheduling of laboratory time during the week is flexible. In addition, the scheduling of the four week units may be divorced from the traditional academic calendar if necessary.

MATERIALS:

Various promotional materials (brochure, letters, news stories, TV film) have been developed. Copies are available from me. Considerable hardware which constitutes the actual modules has also been developed. We will gladly supply detailed descriptions to anyone, and we invite those interested to visit us to see the facilities first hand.

PROBLEMS:

Our one serious difficulty with this program has been lack of response from the industrial sector. We are confident that we have a solid program, and we feel that we have promoted it vigorously. Something has clearly been lacking, however, in our contact with industrialists. We are presently sending out questionnaires in an attempt to pin down what is missing.

Chemical Engineering

PROJECT TITLE: CACHE PROJECT

PROJECT DIRECTOR: Lawrence B. Evans

PROJECT ADDRESS: Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

PURPOSE:

To promote cooperation among universities, industry, and government in the development and distribution of computer related and/or technology based educational aids for the chemical engineering profession.

AUDIENCE:

The immediate audience is the chemical engineering education community - faculty and students. We indirectly influence practicing professional chemical engineers. The CACHE Committee hopes to serve as a model for other disciplines and, thus, have an impact upon the larger scientific and engineering field.

INNOVATION:

The unique aspect of the project is the idea of getting professionals at many different universities, but tied to a common discipline, to work together in the development and dissemination of new types of educational materials.

EVALUATION:

Most materials developed through the CACHE Committee are sent to others not involved in their preparation. The comments by outside reviewers of reports, for example, are included as an appendix to the report.

MATERIALS:

A seven-volume compilation of 125 computer programs written in a standard language, documented in a uniform format, and used successfully in the classroom have been published along with a description of how they are used. Reports have been issued containing guidelines for FORTRAN computer programs, a design of an educational physical property information system, suggestions on use of real-time computing in the chemical engineering laboratory. A workshop was held to promote the use of digital computer for dynamic simulation. Other instructional material, reports, and workshops are in preparation.

PROBLEMS:

On the whole, the project has been more successful and the products of the CACHE Committee's efforts have been better received than we would have imagined when it was initially funded in 1970. Closer contact with NSF during the first two years of the project would have attuned us to changing goals of NSF Education Directorate more quickly. We probably should have paid closer attention, earlier, to the importance of independent evaluation of the products of the project.

ADDITIONAL COMMENTS:

A paper, "Computers in Education: How Chemical Engineers Organized the CACHE Committee" by W. D. Seider, L. B. Evans and A. W. Westerberg published in the Educom Bulletin, Volume 8, No. 2, Summer 1973, pages 10-17 provides a good description of the CACHE Project. Reprints are available from the Commission on Education, National Academy of Engineering, 2101 Constitution Avenue, N.W., Washington, D.C. 20418 (Telephone 202-389-6417).

PROJECT TITLE: MASTER OF SCIENCE DEGREE PROGRAM IN MANUFACTURING ENGINEERING

PROJECT DIRECTOR: Geoffrey Boothroyd

PROJECT ADDRESS: Department of Mechanical and Aerospace Engineering
University of Massachusetts
Amherst, Massachusetts 01002

PURPOSE:

The purpose of this project is to develop a graduate program in Manufacturing Engineering.

AUDIENCE:

The program is intended for graduate engineers or the equivalent who are likely to become involved in either manufacturing or design in the future. Although the grant was only received earlier this year, we were successful in starting the program in September with four M.S. students. We expect these numbers to increase gradually over the next few years.

INNOVATION:

Since this program is jointly offered by the Departments of Mechanical and Industrial Engineering, it is an interdisciplinary program. Much of the innovation in the program is connected with the use of laboratories for teaching purposes.

EVALUATION:

During the last semester we have completed two evaluations by industrial representatives. First, a group of senior manufacturing engineers from various industries in Massachusetts spent one day at the University discussing the program and were able to provide good advice and many helpful comments. Second, a group of senior manufacturing engineers from the various divisions of Raytheon spent a day at the University discussing the program and were very interested in the possibility of us offering a similar program in Boston on a part-time basis for their own engineers. We are also in the process of having the courses evaluated by the four students presently involved.

MATERIALS:

Teaching materials are being developed for certain courses in the program, but it is too soon to have these made generally available.

PROBLEMS:

The most serious difficulty we have encountered is connected with the approval of the program by the University of Massachusetts authorities. New graduate programs of any kind are given low priority at present and although the proposal for the program filtered through the various stages of faculty approval with no difficulty, considerable

delays are being encountered at the highest levels of the University administration. It is our understanding that the program proposal will be finally presented to the Board of Trustees in February where we expect to receive a positive recommendation. We must also admit to certain difficulties due to the interdisciplinary nature of the program. Almost all of the effort has been made by the faculty of the Mechanical Engineering Department whereas we had hoped that the Industrial Engineering Department would perform an equal function with regard to the recruitment of students.

Statistics
Decision and Control

PROJECT TITLE: A MASTER OF SCIENCE PROGRAM IN APPLIED MATHEMATICS

PROJECT CO-DIRECTORS: A. P. Dempster and Y. C. Ho

PROJECT ADDRESS: Harvard University
Cambridge, Massachusetts 02138

PURPOSE:

The purpose of the grant is to initiate a professional masters program in the areas of Statistics, Decision and Control.

AUDIENCE:

The program is formally under the Committee on Applied Mathematics which encourages the development of specialized masters programs for mathematically able students who wish to apply mathematical tools in the course of technical or professional careers. The program is just beginning, with two students currently enrolled.

INNOVATION:

The program has the following innovative features:

(1) students are required to register at Harvard for two summers and two semesters to complete the degree;

(2) internship or industrial practice at organizations or firms in the Greater Boston area is an integral part of the students' educational experience;

(3) various automated teaching techniques are being developed and employed not only to free the students from the space-time limitation of the traditional academic schedule but also to increase the effectiveness of information transfer.

EVALUATION:

Evaluation is currently informal. The initial classes are small enough that direct feedback from students to faculty is enabling us to get good ideas for how the course designs need modification. Final evaluation will require the study of several years of experience by students while here and after they leave.

MATERIALS:

Two courses, one on decision-making and one on statistical inference, are being prepared in self-paced format using audio tapes in addition to written materials. Two other workshop courses are being developed, which stress direct applications of techniques, and require the students to process real problems.

Mathematics
Multidisciplinary

PROJECT TITLE: PROJECT CALC

PROJECT DIRECTORS: Harry M. Schey and William U. Walton

PROJECT ADDRESS: Education Development Center
55 Chapel Street
Newton, Massachusetts 02160

PURPOSE:

The purpose of Project CALC (Computer and Laboratory Calculus) is to provide a calculus course for students whose mathematical backgrounds are too weak for them to learn the subject from standard courses and texts. Our course makes use of laboratory experimentation and real world phenomena to underscore the fact that mathematics in general, and calculus in particular, are not necessarily abstract studies, but can be used to understand and even control those phenomena.

The primary goals of the core course are

1. to reduce the widespread fear of mathematics and increase mathematical literacy so that a student will be able to comprehend the mathematics in texts and journals

2. to enable the student to translate mathematics into English and vice versa

3. to enable the student to understand "everyday" quantitative concepts (e.g. "The rate at which inflation is growing decreased last month") and generally to increase the use of mathematical thinking in everyday life

4. to enable the student to apply elementary calculus to set up and solve relatively simple problems in his field of interest

5. to teach the student to model real world phenomena so that he may move easily from a real phenomenon to a mathematical abstraction of it and then to an interpretation of mathematical results in real life terms.

AUDIENCE:

The core course is aimed at

1. non-physical science majors requiring mathematics training to pursue their academic work (examples are pre-medical students, as well as students majoring in psychology, economics, architecture, forestry, etc.)

2. students with weak background in mathematics who are not prepared for a standard college calculus course of the kind presently available

3. students who would otherwise take college algebra or finite mathematics to fulfill a mathematics requirement.

We believe the course will be appropriate in community colleges, technical training schools, liberal arts colleges, and schools offering pre-professional programs.

INNOVATION:

The course also uses computers to illustrate points in a direct numerical way rather than abstractly, and to eliminate the drudgery of excessive computation. Perhaps most importantly, numerical methods help us to teach calculus without relying heavily on algebra, a subject in which the student is probably weak at the outset. In this way algebraic skill, ordinarily a prerequisite for the study of calculus, can be introduced gradually and taught as needed in conjunction with the calculus.

To meet the goals for these students there are several unusual features of the course.

Numerical Approach Using Computers:

The limited mathematical preparation of the students dictates a numerical approach at the start of the course rather than a symbolic one. Thus calculators and/or computers are used to take the drudgery out of arithmetic and make it possible for the student to deal with problems that are realistic and interesting. The student is forced to think logically and precisely as he formulates a problem for computation. In addition, for many people the computer holds a strong fascination which we are quite candidly exploiting. However, the aim of this course is not to teach numerical analysis in any rigorous sense but to allow students to see the power and use of calculus before they get into more abstract ways of dealing with integration and differentiation.

Laboratory:

Experimentation and the use of experimental data are central features of our work and are intended to stimulate in the student the need and the desire to understand more mathematics. The laboratory makes it clear that mathematics is relevant to an understanding of real phenomena and demands of the student that he formulate and test models of systems--physical, economic, chemical, or biological--and develop an ability to construct and use such models. Because laboratory experiments are drawn from a variety of fields, the student comes to appreciate the profound usefulness of mathematics.

Self-paced Flexibility:

Although these materials could be used to supplement a standard lecture-recitation course, the self-paced mode in which the course is intended to be taught allows the student to work on his own at home, in the tutoring room, in the laboratory or at the computer, whatever is

appropriate for the particular problem at hand. Each unit offers explicit objectives and suggestions to the student. A tutor is available to offer help and determine when a student is ready to move to the next unit. If the student cannot pass the unit quiz with 95 percent mastery, he returns to the unit for more preparation.

EVALUATION:

We believe this course can greatly increase the mathematical literacy of many people who, in the past, have not been adequately served by available mathematical courses. We believe it will be of particular value to people in many fields, such as the life sciences, the health professions, and business, as well as to technicians and technologists. It may also serve as a bridge to standard elementary calculus courses for students whose backgrounds in mathematics are too weak to profit from such courses without preparation of the kind our materials will make available to them.

MATERIALS:

As written, this course is divided into units to be used in the Keller Plan ("self-paced") mode. Taken together, however, the units constitute a text which could be used in the more standard lecture format.

Anthropology

PROJECT TITLE: A PROJECT TO FILM THE YANOMAMO INDIANS OF SOUTHERN VENEZUELA FOR ANTHROPOLOGICAL TEACHING AND RESEARCH

PROJECT DIRECTOR: Timothy Asch

PROJECT ADDRESS: Department of Anthropology
Brandeis University
Waltham, Massachusetts 02154

PURPOSE:

The purpose of our project is to find ways of using film and written resources to engage introductory anthropology students in an enactive process of learning, not possible without the use of film.

AUDIENCE:

Introductory anthropology students.

INNOVATION:

We are making short films on specific sequences of interaction in Yanomamo society, which with the written material, we plan to contrast with similar resources on other societies, such as the Bushmen of the Kalahari Desert of South West Africa, the Netsilik Eskimos, and the Australian Bushmen.

EVALUATION:

So far the material has been used and evaluated in a variety of college introductory anthropology courses. Both intuitive evaluations and formal evaluations have been made on this work. (Intuitive: course exams, and my paper "Using Film and Teaching Anthropology: One Pedagogical Approach" written for the 9th International Congress of Anthropological and Ethnological Sciences, Chicago, 1973: formal: "The Netsilik Eskimos on Paper and on Film," DeVore, P. and Lazaris, N., 1972).

MATERIALS:

So far we have developed eleven films on various topics of Yanomamo culture; they are available from The National Audio-Visual Center, The Pennsylvania State University Audio Visual Services, and Documentary Educational Resources.

The book, Studying the Yanomamo, directly complements this work. (Chagnon, Napoleon. Studying the Yanomamo, Holt, Rinehart & Winston, New York, 1973.) This book has just been published in conjunction with these films.

The films are the following:

THE FEAST. (1971). (29 minutes). Currently available. Winner of numerous awards, including Cine 1970 and the First Prize in the 1972 American Film Festival (educational films). This film focuses on practices and how feasting and trading create and maintain political alliances between two once-hostile villages. It illustrates

the material presented in Chapter 4 of The Fierce People, and is widely used in conjunction with that book. See review by Kenneth Kensinger, 1971. (Kensinger, Kenneth, 1971, review THE FEAST, American Anthropologist, 73, 500-502.)

YANOMAMO: A MULTIDISCIPLINARY STUDY. (1971). (43 minutes). Currently available. Winner of numerous awards, including Cine 1971 and Second Prize in the 1972 American Film Festival (educational films), competing in the latter against THE FEAST. This film describes the nature of the multidisciplinary fieldwork conducted by Chagnon and his American and Venezuelan colleagues on the 1968 expedition to the Yanomamo area. The relationship between demography, human genetics, serology, epidemiology, linguistics, physical anthropology, cultural anthropology, and other medical disciplines is graphically shown through the efforts of specialists as they collect blood specimens, make dental examinations, and participate in other ways in the fieldwork. The film also includes a brief, but comprehensive, description of Yanomamo culture. It is extremely useful in introductory courses in anthropology where the relationship between physical anthropology, cultural anthropology, and linguistics is given in the classroom. See reviews by Paul Baker (1972) and Michael Hannah (1972). (Baker, Paul, 1972, review of 16mm film YANOMAMO: A MULTIDISCIPLINARY STUDY, American Anthropologist, 74:195-196): (Hannah, Joel M., review of YANOMAMO: A MULTIPISCIPLINARY STUDY, American Journal of Physical Anthropology, 36:453-454).

MAGICAL DEATH. (1973). (29 minutes). Currently available. This film focuses on the role of the shaman, Dedeheiwa in this case, in curing his co-villagers and sending sickness to enemy villages. The use of hallucinogenic snuff is shown in its daily context. More important, this film illustrates how religion serves political ends and how shamans can manipulate the spirit world to demonstrate their allegiance to allies. Like THE FEAST, this film focuses on one specific event and describes its development in terms of the history of political relationships between two villages, Bisaasi-teri and Mishimishimabowei-teri, that are entering into a new alliance. It is a very powerful and dramatic film and should be used in conjunction with lectures and/or with one of the mythology films (MYTH OF NARO). See review by Eric Wolf, 1972. (Wolf, Eric, 1972. Review of 16mm film MAGICAL DEATH, American Anthropologist, 74: 196-198).

OCAMA IS MY TOWN. (23 minutes) This film describes fourteen years of activity of a Salesian priest in an attempt to acculturate a village of Yanomamo on the Ocamo River. The difference in approach, attitude, and philosophy of this missionary contrasts in many ways with similar approaches made by the members of the New Tribe Mission.

ARROWS. (9 minutes). A large group of boys engage in an arrow fight in the village clearing, shooting blunt arrows at each other to learn how to dodge arrows as well as shoot accurately. The game ends when one of the boys, Moawa's son, is injured and falls to the

ground with a minor wound on his cheek. His father breaks up the game by brusquely threatening to "revenge" his son.

DEDEHEIWA WEEDS HIS GARDEN. (23 minutes). This is a quiet film about one aspect of Dedeheiwa's daily life. He cleans the weeds out of his maturing manioc garden and rests while his wife tenderly delouses him. About a dozen children, most of them his own, crawl over him in their play activities.

DEDEHEIWA WASHES HIS CHILDREN. (15 minutes). Dedeheiwa takes a number of his young children to the river and washes them carefully and patiently while his sick wife remains in the village.

CHOPPING WOOD. (10 minutes). The irksomeness of daily wood collection is revealed as a woman patiently and strenuously chops a large log into kindling for her hearth.

MOAWA MAKING A HAMMOCK. (12 minutes). The village headman, Moawa, patiently works on a hammock while his wife looks on and fondles his leg periodically.

CHILDREN'S MAGICAL DEATH. (7 minutes). A group of young boys, ranging in age from five to ten years, emulate their fathers by pretending to be shamans. They blow large quantities of make-believe drugs (ashes from the hearth) into each others' nostrils and become shiwaryo (intoxicated) from the make-believe drugs. They prance as shamans and fall "unconscious" from their efforts.

COLLECTING RASHA FRUIT. (9 minutes). A young man patiently and carefully ascends a thorny rasha tree to harvest the fruit. He ascends the prickly tree with the ingenious device, a pair of climbing scaffolds.

Multidisciplinary

PROJECT TITLE: COLLEGE IV

PROJECT DIRECTOR: Robert J. Toft

PROJECT ADDRESS: College IV
Grand Valley State Colleges
Allendale, Michigan 49401

PURPOSE:
To develop an entire college based on self-pacing and mastery learning.

AUDIENCE:
Eighteen to twenty-two year old undergraduates, plus adult and continuing education students.

INNOVATION:
Half-credit learning modules as the units of instruction, total self-pacing, mastery learning, variable credit learning contracts, on-line student record keeping and retrieval.

EVALUATION:
Outside evaluation team studying both process and outcomes.

MATERIALS:
A whole curriculum of learning modules, some commercial materials used.

PROBLEMS:
Interfacing a timeless program with a time-based university system. Developing the computerized record keeping and retrieval system. The enormous expenditure of energy in writing the curriculum of modules.

ADDITIONAL COMMENTS:
Two hundred students enrolled initially, most of them working full time at other jobs. Self-pacing really opens access to many previously disenfranchised because of scheduling difficulties.

Engineering

PROJECT TITLE: COMPUTER INSTRUCTIONAL AIDS FOR UNDERGRADUATE CONTROL EDUCATION

PROJECT DIRECTOR: Richard A. Volz

PROJECT ADDRESS: Department of Electrical & Computer Engineering
University of Michigan
Ann Arbor, Michigan 48104

PURPOSE:

The purpose of this project was to develop a set of computer analysis and design programs for control systems which could be integrated into a basic undergraduate control sequence and which utilized heavily computer graphic capabilities. To provide the student with a comprehensive view of what can be accomplished with computer aids the system developed was to include the operations appropriate to elementary control courses and to illustrate the advantages of both digital and hybrid computation.

AUDIENCE:

The material developed was intended for use in undergraduate courses in automatic control theory. Thus far, the digital programs developed have been used in the basic undergraduate control course and in an associated laboratory. The hybrid system developed is used as the basis for about 60 percent of the laboratory work and is also used in a course Dynamic Systems and Modelling. Both have been used on an irregular basis for demonstration in other courses.

INNOVATION:

There are two aspects to the work developed, a time-shared hybrid control system simulator and a set of digital computer aided design programs each of which operate from graphic terminals. The former is built around the use of a single general configuration control system programmed in a time-shared manner on a hybrid computation system. A wide variety of specific systems can be obtained by selectively zeroing unneeded portions of the system. Student users operate from graphic terminals and select from among predefined problems those which they wish to study. Parameters in these may be varied from the terminals and the responses observed. Typical response time is on the order of a few hundred milliseconds.

The digital phase of the work has been dubbed COINGRAD (Control Oriented Interactive Graphic Control Analysis and Design) and encompasses time response, frequency response and root locus calculations. Though intended primarily for interactive use through a graphics terminal such as the Computek or Tektronix terminals, the program will function from standard teletype terminals or in batch mode. They operate with a simple command structure through which the student can enter his program description in as close to natural language as possible, and simply ask for the solutions he desires. In addition a limited optimization capability is included.

EVALUATION:

No formal evaluation of the utility of the computer projects themselves was conducted. However, some feedback is obtained from course evaluation forms and informal feedback from students was sought. In general, except for the occasional hardware failures, the programs have been well received.

MATERIALS:

Copies of the source code for all digital programs developed and the analog and logic diagrams for the hybrid functions are available from the principle investigator. Most of the digital programs developed were written in Fortran. However, a number of system and library programs available at Michigan were utilized which are available only in assembler form. Also, a movie illustrating the hybrid simulator is available for loan.

PROBLEMS:

Other than the usual debugging problems which arise, the items which have been noted are:

1. Hardware failures. This has occurred with both the hybrid system and the digital terminals. Diagnostic programs usually allow the hybrid problem to be found without too much delay and remedied by component replacement. These problems usually are the result of improper use of the hybrid equipment by students in other courses. Occasionally noise on the data lines causes difficulty. Failures on the digital terminals and hard copy unit have been particularly annoying, with repairs often taking several weeks, due to the delay in getting replacement parts.

2. Access to the digital facilities during normal daytime hours is sometimes a problem due to high system usage during this time. Late in the term it may be difficult to even sign on the system during these times. Late evening and weekend hours are not permitted due to theft problems.

3. Difficulty in transferal of programs to other systems is a potential problem. It has not been attempted yet, but the use of system and library programs existing only in assembler form is likely to cause problems. With additional funds many of these could be rewritten in a higher level language, and some of the COINGRAD features modified to be more amenable to system transferal.

Engineering

PROJECT TITLE: DEVELOPMENT OF UNDERGRADUATE COMPUTER COURSES

PROJECT DIRECTOR: Keki B. Irani

PROJECT ADDRESS: Department of Electrical and Computer Engineering
The University of Michigan
Ann Arbor, Michigan 84104

PURPOSE:

The purpose of this project was to develop material for teaching basic undergraduate courses in the logical design of digital circuits and the organization and architecture of digital computers. The philosophy was to develop material as disjointed components or modules, each of which could be used for a separate aspect of the overall goal.

AUDIENCE:

The material has been used in two undergraduate courses and one graduate-undergraduate course. Also, a movie has been produced to disseminate information about one of our undergraduate logical design laboratories.

INNOVATION:

The material focuses on various levels of digital circuits, viz., the gate level, the register transfer level, the microcomputer level and the minicomputer level.

Software support packages have been generated for the use of various equipment. A simulator has been written for register transfer module design for those who do not have access to such equipment.

Two movies have been produced, one of which surveys the traditional combinational and sequential logic circuits and the other explores a typical digital computer engineering laboratory. The former was produced using computer-aided animation techniques. The animation, particularly in describing sequential circuits, gives the student deeper insight than typically possible with a blackboard presentation.

EVALUATION:

Constant feedback and evaluations by students have been the main mechanism for the evaluation of some of the components generated by the project.

MATERIAL:

1. A set of experiments for a first course in digital design and computer organization has been developed. It contains a set of programming experiments to be conducted on a minicomputer and experiments on simple digital circuits. A set of laboratory lecture notes have been developed and also developed are programs to check programs written by students.

2. A 40-minute movie to explain combinational and sequential logic circuits has been produced.

3. A set of experiments has been developed for a second course in logic circuit design. A movie called Digital Computer Engineering Laboratory is produced to explain a typical digital design laboratory.

4. Also produced as tools for use in the digital design laboratories are the following programs:

   Using * WIRE WRAP for PDP-16 Register Transfer Module.

   Michigan Intel MCS-8 Programmer and Loader System.

   Michigan Intel MCS-8 Assembly.

   SIM-16, a simulator of PDP-16.

Any of this material may be obtained either from myself or from Professor D. E. Atkins, Department of Electrical and Computer Engineering, University of Michigan.

PROBLEMS:

1. Insufficient finances for acquiring equipment.

2. Obsolesence of software due to changes in hardware.

3. Transportability of experiments and software to equipment manufactured by a different company.

Physics

PROJECT TITLE: EDUCATIONAL FILMS VS PRINTED MATERIAL

PROJECT DIRECTOR: Peter Signell

PROJECT ADDRESS: Michigan State University
East Lansing, Michigan 48823

PURPOSE:

The purposes of this project are twofold:

1. to produce several short films which will motivate learners with diverse interests to study sophisticated Physics and Analysis, and which will provide learners with mental core-images around which they can more easily build-in new knowledge; and

2. to determine the extent to which such films can be effectively supplemented or replaced by a series of stills and accompanying text. The advantages of the stills-alternative include: lower cost of production, lower purchase cost, and physical retention by the learner.

AUDIENCE:

The audience is mainly intended to be lower division undergraduates, but the materials should also be profitable for all levels from advanced high school students to college faculty and research personnel.

INNOVATION:

Innovations include the subjects treated, method of exposition, and the method of verification. The subjects are: "The Relationship Between the Real and Imaginary Worlds as Communicated Through Resonances" and "The Transition From Particle to Wave During the Approach to Exponential Decay". Both of these subjects involve rather profound ideas normally realized with sophisticated mathematics. We realize them through computer-driven graphics. For verification and revision, we will make use of learners who are enrolled in a local self-paced PSI course. Learners who elect these modules will be interviewed and their mastery-model success rates will be followed. Learner interest will be judged by the fractions of learners who elect these modules.

EVALUATION:

Evaluation of materials has so far been accomplished by exposure of their successively-revised forms to a succession of naive subjects. This process has taken several years. See also the procedures mentioned in Innovations above.

MATERIALS:

Materials produced so far include one prototype film, one revision-stage film, one editing-stage film, and one Stills Alternative Study Guide. A distributor has not yet been selected but Wiley and McGraw-Hill have indicated considerable interest.

PROBLEMS:

Problems have been mostly connected with the necessity for large amounts of time for the innumerable revisions mentioned in Evaluation above. In doing it over, I would hire more student-staff earlier and allow more time for the project.

ADDITIONAL COMMENTS:

We have learned a number of film techniques which we will pass on to our colleagues via publication. These include: (1) pedagogical superiority of double to separated images; (2) superiority of art-type lettering on acetate for overlays; and (3) an unexpected superiority of lap dissolves to true animation for pedagogical purposes.

Electrical Engineering

PROJECT TITLE: ELECTRODYNAMICS

PROJECT DIRECTOR: W. D. Getty

PROJECT ADDRESS: University of Michigan
Ann Arbor, Michigan 84104

PURPOSE:

This project is concerned with lecture demonstrations and laboratory experiments in the areas of electromechanics and electromagnetics. The aim is to improve the motivation of undergraduate electrical engineering students in these courses, and to provide the opportunity for students to observe and use devices.

AUDIENCE:

The project is aimed at the junior and senior level courses in fields and electromechanics. Many of the demonstrations have been used for 3 years at The University of Michigan. Some of the demonstrations have been found useful for freshman classes.

INNOVATION:

Many of the demonstrations are unusual and novel. An attempt has been made to make them reasonably self-contained so that auxiliary equipment is kept to a minimum.

EVALUATION:

The results of the project have been evaluated thus far by the reactions of the students who have helped develop the demonstrations, the students in classes in which the demonstrations have been used, and the faculty members who have used them. In general, the reactions have been very encouraging.

MATERIALS:

A working model of each demonstration has been constructed and a report giving complete details on construction, operation, and theory is under preparation.

PROBLEMS:

The most serious difficulty encountered in this project was the lack of suitable manpower. This was brought about by the large amount of hardware that was designed and built for the project. The project could have been completed faster if a graduate engineer had been available to handle the design details.

Electrical Engineering

PROJECT TITLE: UNDERGRADUATE CURRICULUM PROGRAM IN DISPLAY-BASED INSTRUCTION

PROJECT DIRECTOR: D. A. Calahan, R. J. Lomax, C. W. McMullen

PROJECT ADDRESS: Department of Electrical and Computer Engineering
University of Michigan
Ann Arbor, Michigan 48105

DESCRIPTION:

This project involves the investigation of the use of graphic displays in the teaching of electrical engineering undergraduates.

The project was initiated at a time when storage tube graphic terminals were first becoming available. It was felt that an attachment of four of these terminals to a remote (university) computer via public phone lines offered a range of computational power and interactive capability worthy of a number of experiments involving sophomore through senior level students.

A FORTRAN-callable graphics library was first developed; next, over twenty five instructional programs were completed, ranging from small programs to display and design antenna field patterns to large display-based circuit analysis programs for use in design courses. Three one-hour movies describing the use of these programs were also prepared. All of these programs will become public domain and available at the termination of the grant from the principal investigator. Three papers have been published in electrical engineering journals on these investigations.

It must be reported that few of these programs will be used beyond the grant termination. The major reasons are (1) the relatively high unreliability of terminal hardward (2) the near saturation of the university's computing system. Although these discouragements can be compensated (e.g. holding evening sessions or assigning optional problems) impartial instructors are hesitant to prescribe this mode of instruction when other more standard modes exist. This is especially true in basic required electrical engineering courses, where student survival is a major concern.

Present investigations involve the use of a more reliable smart stand-alone terminal to avoid the above difficulties. We expect to demonstrate one or more of these at the meeting.

Electrical Engineering

PROJECT TITLE: AN UNDERGRADUATE PROGRAM IN MEASUREMENTS AND INSTRUMENTATION

PROJECT DIRECTOR: William B. Ribbens

PROJECT ADDRESS: Electrical and Computer Engineering Department
The University of Michigan
Ann Arbor, Michigan 48104

PURPOSE:

The purpose of this project was to improve undergraduate courses in measurement and instrumentation and to report these improvements for use at other universities.

AUDIENCE:

The intended audience for the developments on this project are the people who are now teaching undergraduate courses in instrumentation.

INNOVATION:

Perhaps the most innovative aspect of this project is the development of a systematic procedure for the design of an instrument which is capable of making measurements with maximum possible confidence in the results. The procedures developed in this project treat all uncertainty in any measurement as an equivalent noise. Measurements in which there is maximum confidence in the results are those for which the resulting display has the highest signal/noise. Signal processing procedures for maximizing this ratio are presented.

Another innovating aspect of this program has been a study of the value of a student design project in one of the instrumentation courses. The project assignment is selected to utilize most of the important principles taught in the course. It was learned that a design project provides an important continuity and motivation for the course.

EVALUATION:

The primary emphasis of the project has been the development of new teaching methods in an undergraduate instrumentation program. Therefore, standard course evaluations provide a meaningful evaluation of the project. In addition, however, there have been lectures and seminars at other universities and at conferences to test the reaction of other faculty to the newly-developed ideas.

MATERIALS:

A new text has been written and published as a result of the NSF project. In addition a series of new laboratory experiments have been prepared including a new laboratory manual and instructional laboratory equipment.

PROBLEMS:

The most difficult problem encountered on this project was finding a publisher who was willing to gamble on the preparation of a new text book in the fact of falling engineering enrollment.

Mathematics

PROJECT TITLE: COLLEGE GEOMETRY PROJECT

PROJECT DIRECTOR: Seymour Schuster

PROJECT ADDRESS: The University of Minnesota
Minneapolis, Minnesota 55455

PURPOSE:

The aim of the project was to produce materials for teaching geometry at the college level, particularly for prospective high school teachers. The materials (which were judged to be needed in the early 60's) were to inject into the curriculum stronger geometric training than existed at that time.

AUDIENCE:

The primary audience was prospective high school teachers of geometry. However, the materials developed with sufficient breadth as to be useful to prospective mathematicians and mathematics-users as well as mathematics teachers. The written materials have, in part, been used at over a hundred colleges in the United States, while the visual materials have had far more extensive use including foreign countries.

INNOVATION:

The written materials were unusual in the sense that they were "semi-programmed" requiring students to answer questions and provide proofs in the body of the text, in a manner analogous to a class in which the teacher continually generates student response. The films were experimental in a variety of ways. In fact, the project director felt that the NSF support for the production of films was essentially for striking out in new directions vis a vis the mass production of mathematical films much like those that were then on the market.

EVALUATION:

Questionnaires drawn up with the assistance of a psychologist were studied as responses from perhaps 250 viewings of mathematical films. The evaluation of the written materials were obtained mainly by the analysis of the responses to the programmed instruction by people trained in mathematics and educational psychology (specializing in the study of programmed instruction).

MATERIALS:

Nine short books on various geometric topics, twelve mathematical films and one film-strip. The written materials are no longer available in quantity. Unfortunate circumstances have led to various commercial publishers withdrawing from promises to publish the materials. The films are available from the International Film Bureau, Inc. in Chicago.

PROBLEMS:

The most serious difficulties were those that were encountered as a result of overestimating the abilities of the University to adjust to the problems of experimental film making when it had no previous experience with such undertakings. If it were to be done over again, I would like to be sure that the physical, mechanical and administrative problems of running an experimental film studio were all resolved before the project got underway.

Mathematics

PROJECT TITLE: DEVELOPING A NEW MATHEMATICS PH.D. OPTION AT THE UNIVERSITY OF MONTANA

PROJECT DIRECTOR: Robert McKelvey

PROJECT ADDRESS: University of Montana
Missoula, Montana 59801

PURPOSE:

To train mathematical "generalists," individuals whose professional concern is with the broad sweep of mathematical science, and its impact upon modern thought and society.

AUDIENCE:

Teachers and potential teachers in undergraduate colleges, and individuals who intend to apply mathematics to problems arising in other disciplines and in interdisciplinary work. Since we regard ours as a demonstration program which we hope will be imitated, we are being highly selective in choosing students to participate in the program.

INNOVATION:

We emphasize

1) Breadth of knowledge, across the whole spectrum of mathematics and into neighboring disciplines, and perspective into the historical development of contemporary mathematics;.

2) Awareness of the problems of synthesis, interpretation, and communication of mathematical thought, and attention to the skills needed to express mathematical ideas orally and in writing;

3) A sense of vocation as teacher and scholar, functioning as a productive member of the institution and of society;

4) An orientation toward scholarship and continuing self-development throughout the professional career.

EVALUATION:

The program's success will be measured by the ability of our graduates to secure and excel in responsible professional positions. It will also be measured by the degree to which our approach is accepted and adapted by others to their graduate training programs.

MATERIALS:

For us it is all "software": We have been experimenting with several new courses and seminars: on modeling, on applications in the sciences, and one which examines the profession of college teacher.

PROBLEMS:

(a) Overcoming initial skepticism within our mathematics department, this university, and the mathematics community nationally.

(b) Recruiting superior candidates at a time when graduate education in mathematics is in severe decline.

(c) Arranging suitable opportunities for participation of our graduate students in interdisciplinary projects--often we seem to have to organize these projects ourselves!

Multidisciplinary

PROJECT TITLE: DOCUMENTARY FILM PROJECT

PROJECT DIRECTOR: Norman N. Miller

PROJECT ADDRESS: American Universities Field Staff
Box 150
Hanover, New Hampshire 03755

PURPOSE:

To develop a series of twenty-five educational films on the ways in which rural people adapt to different ecological environments. Key aims are to show the ways of surviving in different agricultural locals, and the ways the young are taught to adapt to different agricultural, fishing and herding life-styles.

AUDIENCE:

University classrooms. The project has not disseminated materials as yet. The potential audience includes university and college students, secondary students, community organizations and educational television.

INNOVATION:

Format of five films on each of five locations which permits flexible usage, and allows instructors to build presentations on either a thematic or cultural basis, (see diagram under Materials). Use of observational film methods to produce material that can pose problems and serve as evidence for teaching and research, is another innovation.

EVALUATION:

Constant screening of materials for students and instructors as project proceeded through editing phases.

A more formal evaluation program is planned with the films in conjunction with written educational materials that are being developed.

MATERIALS:

Twenty-five films on five themes in five societies.

Film Project Format

	Rural Society	Education	Economics	Women	Miscellaneous
Bolivia	0	0	0	0	0
Kenya	0	0	0	0	0
Afghanistan	0	0	0	0	0
Taiwan	0	0	0	0	0
China Coast	0	0	0	0	0

Main Films
30-38 minutes

Support Films
10-18 minutes

PROBLEMS:

The project has been underway nearly three years and was in a planning stage two years prior to this production period. The logistics problems range from a threatened elephant attack in Kenya to current laboratory strikes and a three-day industrial week in England (the project base). Personnel problems lie basically in the conflict of interests between a science orientated research approach and the artistic orientation of most filmmakers. Audience problems lie in learning how to use film most efficiently, how to see film as evidence and not entertainment, and how to use films to pose questions and stimulate learning. Other problems lie in translating research findings into useable film, and teaching location crews to understand something of the culture of rural peoples. This we did by using Field Staff Associates who have depth knowledge of local areas to lead the film crews and serve as their chief translator and co-director in the on-location work.

The most basic changes I would make on a second attempt would be in more realistic scheduling of the work in post-production (editing) phases.

Geographer

PROJECT TITLE: FILM INTERVIEW SERIES

PROJECT DIRECTOR: Maynard Weston Dow

PROJECT ADDRESS: Plymouth State College of the
University of New Hampshire
Plymouth, New Hampshire 03264

PURPOSE:

The purpose of this series of film interviews is to capture the personality of leading geographers so as to leave a permanent record for present and future generations of students and scholars. It is an attempt to preserve for posterity the principals of geography as they comment briefly about themselves and conceptual things.

AUDIENCE:

Students and faculty who examine individual geographers in seminar and lecture-discussion. The films add interest and real meaning to these sessions. To date, over sixty institutions have utilized the series.

INNOVATION:

The interviews stress specific developments of seminal geographic subfields and theories as well as the work of geographers in the areas of editing, planning, and administration. Interviews have been selected to insure that the individuals and ideas represented are dynamic indicators of the growth and development of science and of geography. They reinforce the notion that the growth and development of science occurs not only in a sterile laboratory context, but also depends upon creative efforts, persistent research, risks, and experimentation by scientists. In addition, the series focuses upon the controversies within the geographic community that have sharpened the direction of research, stimulated new ideas, and developed alternate routes for different kinds of geography.

An important advantage of the films is that they serve to provide enrichment for geography programs which cannot afford visiting scientists or lecturers.

Finally, the series serves as an archival collection of the oral history of American geographers.

EVALUATION:

The films are constantly evaluated by users whose generous oral and written comments are frequently received. Approximately sixty institutions have borrowed them and as of January 24, 1973, twenty additional requests for the spring semester had not been processed.

During April, 1971, at the annual meeting of the Association of American Geographers (Boston), over 250 geographers saw samples of the films and 115 viewers completed the enclosed questionnaire.

MATERIALS:

Fifty-eight interviews have been produced and presently 40 are available for rental. The fee varies from $5.00 to $15.00, depending upon the length of the interview (ten to thirty-five minutes).

PROBLEMS:

Technical difficulties have resulted in uneven quality of production. The interviews are produced in either 16mm black and white film or one-inch TV tape, which is subsequently converted to 16mm Kinescope. Better equipment can reduce this deficiency.

Distribution is also a problem. In an attempt to keep the rental fees as low as possible I have handled all correspondence and film requests myself. It has been very time consuming, and a part-time assistant should be hired to handle this aspect of the project.

Maintenance and storage of films is a problem and must be budgeted for if facilities are not provided. At present, the entire operation is handled out of my faculty office.

Environmental Studies

PROJECT TITLE: A PROGRAM IN ENVIRONMENTAL STUDIES AT DARTMOUTH COLLEGE

PROJECT DIRECTOR: James F. Hornig

PROJECT ADDRESS: Dartmouth College
Hanover, New Hampshire 03755

PURPOSE:

This program is intended to serve as a venture in liberal education rather than in specialized pre-professional education.

AUDIENCE:

It is intended to appeal to the widest possible audience of undergraduates and to provide them with a sophisticated and broadly based introduction to the many issues of environmental concern which have assumed new importance in our society. Equal priority is given to contributions from the Humanities, the Social Sciences, and the Sciences.

INNOVATION:

1) By far the most significant and important determinant for the program's success is the quality and diversity of the faculty who have been drawn to participate in the program. This includes the leadership of two full time faculty members, and the participation of up to a dozen other faculty in the various courses. Participants include members of the Departments of Biology, Chemistry, Physics, Earth Sciences, Geography, Engineering, Economics, Anthropology, the College Chaplain, a director of the Dartmouth Outing Club, a free-lance writer, and a lawyer active in the Vermont State Government.

2) The other significant characteristic of most of the courses has been an emphasis on case studies and real life problems. In many of the courses, extensive use is made of Environmental Impact Statements obtained from the Council on Environmental Quality. Many of these are under active consideration by CEQ and serve as rich sources of stimulating and provocative case histories. The same theme of active participation emerges as field studies in several of the courses. The Policy Formulation course previously mentioned is a most striking example. Students have helped a local town begin its own land use planning activities. A student project concerned with highway siting in Vermont led to a report in person to the governor. Currently, students are planning a complete study of energy and material flows through Dartmouth.

EVALUATION:

A thorough evaluation is planned for this spring, as required by the rules of the faculty. No specific materials for export have been developed, but the details of our experience appear to be of great interest to many people. Responses to written inquiries and personal visits constitute a very substantial "export" activity, and it has been our pleasure to respond to such expressions of interest.

MATERIALS:

The curriculum includes about a dozen courses all of which are intended to supplement and interact with traditional fields of concentration, rather than to stand independently as a traditional "major". There are three introductory courses:

1) Man's Dependence and Effect on his Natural Environment

2) Earth as an EcoSystem

3) Social and Political Aspects of the Environment

These courses are generally taught by teams of two to four faculty members. Number (2) develops subject matter and proceeds from the point of view of the natural sciences, number (3) obviously draws from the social sciences, and number (1) ranges so widely as to be quite impossible to characterize in disciplinary terms. Each of these courses enroll between 50 and 100 students - regarded as reasonably large courses at Dartmouth. They are intended primarily for freshman and sophomores.

A fourth course, "Environmental Policy Formulation" is open to students who have completed the introductory courses. In this course, students working in groups formulate and justify policy measures for local environmental problems.

Finally, there are a group of special topic courses such as:

Human Population Dynamics	Environmental Law
Nature Writers	Independent Study
Land Resources: Policy and Planning	

These courses draw students from a variety of disciplines in their junior and senior year when they can bring experience with them from work in their own fields of concentration.

PROBLEMS:

The principle problems encountered by the program relate to the difficulties in obtaining faculty leadership and committed participation from departmentally based faculty. Despite the fact that the experimental program was conceived and pushed by faculty, it floundered during the first year or so for lack of leadership and dedicated faculty support. Since the appointment of a new director who came as an addition to the faculty and who devotes full time to the program, it has succeeded brilliantly.

Nevertheless, broad based participation of talented faculty remains a nagging problem despite the present euphoria. In part, this stems from the evils of a vested departmental system, but more fundamentally it relates to the difficult general problem of support for educational experimentation in university environment where ideals of scholarship and disciplinary chauvinism are dominant. On the one hand, intellectual initiatives in education are often proposed by young members of the faculty who can least afford to risk their careers by appearing less than dedicated to their home department. On the other hand, it is not always appropriate to bring from the outside a senior person to work with an experimental program which may have a limited future. General faculty support, inspirational leadership and vigorous support of the administration have held these problems at bay, but there is still cause for nervousness.

Multidisciplinary

CONSORTIUM: EDUCOM Interuniversity Communications Council, Inc.
P. O. Box 364
Princeton, New Jersey 08540

EDUCOM, Interuniversity Communications Council, Inc., is a nonprofit consortium of universities, colleges and organizations concerned with higher education. EDUCOM's basic purpose is to assist its members to cooperate in the sharing of physical and intellectual resources in the areas of computer and communications technology.

Since EDUCOM is a membership organization, its semiannual meetings and conferences are an important aspect of the organization's activities. These meetings are used to conduct necessary business and to provide a forum for exchanging ideas and evaluating progress in the application of information and communications technology to higher education. Conferences since 1971 have dealt with the financing and organization of computing in higher education, successful applications of computing in higher education, and uses of computer networks in higher education. Proceedings of all recent conferences have been published and widely distributed.

In the past, EDUCOM organized and presented special seminars such as one on management and organization of computing in higher education designed specifically for presidents and vice presidents of colleges and universities. A conference on Cable Television and the University given in cooperation with the Cable Television Information Center and Educational Testing Service will bring together university officers, faculty, policymakers and other institutional representatives to discuss the opportunities presented by cable and ways in which the universities might respond.

EDUCOM, Bulletin of the Interuniversity Communications Council is a quarterly magazine published by EDUCOM. The Bulletin has a current circulation of over 10,000 and provides reports on presentations at Council meetings, status reports on research projects, notes on applications of technology to higher education, and articles by authorities in numerous fields describing functioning systems of interest to the educational community.

EDUCOM conducts research on the application of computer and communications technology to areas in which the combined resources of its members can achieve significant results. A recently completed study sponsored by the National Science Foundation identified the factors which have inhibited more widespread use of computers in instruction and suggested means for overcoming these obstacles. One current study funded by the Russell Sage Foundation is examining the use of simulation models in socioeconomic policy research. Another current study is examining Academic Computer Planning in the American States and Canadian Provinces.

EDUCOM has developed a consulting service which provides senior consultants with wide experience in higher education to assist and advise

colleges and universities on: how they can fulfill their computing needs most economically; how they can use the computer more effectively in institutional management; where cutbacks can safely be made; and what increased capabilities will yield the greatest benefits in relation to cost and educational effectiveness.

Since its inception, EDUCOM has had a continuing interest in the use of computer networks by institutions of higher education. During the winter of 1972-73, EDUCOM conducted a series of three General Working Seminars for the National Science Foundation. The report on these seminars is available from the MIT Press as NETWORKS FOR RESEARCH AND EDUCATION: SHARING COMPUTER AND INFORMATION RESOURCES NATIONWIDE. Work is continuing on preparatory activities necessary to establish a Planning Council on Computing in Education and Research as recommended by the seminars.

Engineering &
Applied Science

PROJECT TITLE: NONE

PROJECT DIRECTOR: Gabriel Miller

PROJECT ADDRESS: New York University
New York City, New York 10003

PURPOSE:

The aim of the program is to establish a nontraditional educational vehicle to expand the technical expertise of individuals active in research and development in technically oriented industrial concerns.

AUDIENCE:

The program is aimed at individuals who cannot or do not desire to attend traditional graduate programs at Universities but do want to enhance specific technical skills. The program limits the residence requirements of the University by introducing a correspondence curriculum which the students receive at regular intervals. Coupling this mechanism with a one week residency at the University at the end of the term allows the student to earn graduate credit for the course if he so desires.

INNOVATION:

The unique aspects of the program is the extension of the short course and correspondence course concept to allow students to earn graduate credits with a minimum disruption to their vocational objectives and assignments.

EVALUATION:

A panel of educators of the schools involved evaluate the written material. During the one week residency period the students will be asked to fill out questionnaires about the program.

MATERIALS:

The program requires an enormous amount of printed matter which must be mailed. It is felt that at the end of the course what amounts to a text in the specific material has been developed.

PROBLEMS:

The program has run into some difficulty with respect to recruiting large numbers of students from industrial concerns remotely located from the New York Metropolitan Area. Many large industrial facilities have educational arrangements with Universities in their proximity. Problems of students' transfer of credit to these schools also have developed.

We hope, in the next phase of the program, to concentrate our efforts on needs of the technology oriented industrial concerns in the Metropolitan Area. It is felt that we can utilize Saturday mornings to fulfill residence requirements. We will focus the program on the curriculum needs which are most essential to the firms in our area.

Multidisciplinary

PROJECT TITLE: DEVELOPMENT OF A SOCIO-ENGINEERING PROGRAM

PROJECT DIRECTOR: George C. Lee

PROJECT ADDRESS: State University of New York at Buffalo
Buffalo, New York 14214

PURPOSE:

To prepare students with a deep understanding of the relationship between technology and other social systems, and the analytical and technical skills to participate effectively in formulating goals, defining problems and seeking for alternative solutions in areas in which there is a substantial public interest.

AUDIENCE:

Undergraduate students interested in pursuing integration of knowledge among social sciences, natural sciences, applied mathematics and engineering, and applying their knowledge to systems of public interest.

INNOVATION:

All core courses in the program are developed jointly by a team of faculty members with various backgrounds, with a strong complex problem-solving orientation. Internship is required.

EVALUATION:

In addition to student evaluation of courses, an external advisory board visits us yearly to evaluate the progress of the program development. The most important evaluation should come from students several years after their graduation.

MATERIALS:

Under development are four textbooks and a number of associated videotapes. The tentative titles are: Quantitative Methods; Mathematical Modeling in Socio-Engineering; Analysis and Planning of Public Systems; and Implementation and Impact of Public Systems. Manuscripts in lecture note form will probably be completed by September 1975.

PROBLEMS:

Most students enter the program as beginning juniors. The student body already have non-uniform backgrounds in different fields which require much individual attention be given to the students. The other problem is the typical "publish or perish" attitude of the university administration, which discourages faculty participation in developing an undergraduate educational program. However, we would do very much the same if we were to start the project anew.

ADDITIONAL COMMENTS:

We are convinced that new multidisciplinary undergraduate programs must be developed on an integrated basis, not only in each course, but also in the entire package, which is what we are attempting to do.

Engineering

PROJECT TITLE: DEVELOPMENT OF RESOURCE MATERIAL FOR LOWER DIVISION ENGINEERING STUDENTS

PROJECT DIRECTOR: Fred Landis

PROJECT ADDRESS: Dean of Intercampus Programs
Polytechnic Institute of New York
Brooklyn, New York 11201 *

PURPOSE:

At the time the study was begun (1967) engineering freshmen and sophomores had been largely limited to work in the sciences and liberal arts. As a result there was little identification with engineering and significantly reduced motivation. The program attempted to introduce suitably prepared material into the lower division years which could be adopted by various engineering colleges.

AUDIENCE:

Most of the material was developed for direct student use although some of it was designed as instructor resource material.

INNOVATION:

Novel experiments, elementary engineering computer applications, introduction of operations research and systems dynamics on freshman or sophomore level.

EVALUATION:

Favorable comments have been received from recipients of booklet distribution list and, in a number of instances, material has been and is used for class room instruction.

MATERIALS:

The following booklets and reports have been developed with the assistance of various collaborators. All are available at a nominal cost by contacting the Project Director.

B. J. Ley, Manhattan College (formerly at New York University), "Elementary Electrical Engineering Problems and their Computer Solution," 144 pp., November, 1968.

A. H. Church (formerly at New York University), "Computer Solutions of Elementary Mechanical Engineering Problems," 142 pp, September, 1969.

I. B. Cadoff and J. P. Nielsen, Polytechnic Institute of New York, "Laboratory Demonstrations in Material Sciences," 32 pp., April, 1970.

K. N. Astill, Tufts University, "Elementary Experiments in Mechanical Engineering," 128 pp., February, 1971.

* The work was performed while the project director was associated with the School of Engineering and Science of New York University.

L. E. Graff, Baruch College, CUNY, "An Introduction to Operations Research," 121 pp., February, 1973 (available with answer book).

M. J. Rabins, Polytechnic Institute of New York, "An Introduction to Dynamic Systems and Feedback," 70 pp., July, 1973.

Engineering

PROJECT TITLE: DUAL MASTER'S PROGRAM IN ENGINEERING AND IN PUBLIC ADMINISTRATION

PROJECT DIRECTOR: Fred Landis

PROJECT ADDRESS: Dean of Intercampus Programs
Polytechnic Institute of New York
Brooklyn, New York 11201

PURPOSE:

Public policy decisions depend increasingly on technically competent personnel who directly interact with planners, administrators or legislators. Frequently public administrators know little about engineering while engineers know little about policy implementations. The program was set up to develop an integrated dual Master's degree where engineering graduates can pursue both an advanced engineering degree and a Master's degree in Public Administration with a considerable saving in the overall number of credits. Part of the program is a project course where topics spanning engineering and public administration are studied by small student groups under the supervision of faculty from both schools.

AUDIENCE:

Students interested in Master's degrees in engineering and in public administration.

INNOVATION:

Integrated program with credit and time savings, co-ordinated projects courses. The program is an inter-university arrangement where the engineering degree will be awarded by the Polytechnic Institute of New York and the public administration degree by New York University.

EVALUATION:

Program is still in its early stages and no external evaluation is possible as yet. Student reaction has been very favorable.

MATERIALS:

Materials derived from the projects courses will be published on completion of the studies.

The first study was a dynamic simulation of the interaction between national spending patterns in various industry segments, engineering employment or unemployment and the generation of new engineers via United States engineering colleges or through promotion from non-engineering sources. The study can simulate the impact of cyclic fluctuations in the economy on engineering employment and show how pump-priming fund allocations to various segments can speed up the unusually long and slow recovery period following a cyclic downturn.

The second study, currently under progress, deals with projections on residential electric energy use, including saturation limits on appliance use, use elasticity as a function of electric costs, alternative energy source trade-offs for space heating, and possible legislative recommendations regarding appliance efficiencies.

ADDITIONAL COMMENTS:

The program was initiated at New York University's School of Engineering and Science and Graduate School of Public Administration. The engineering component of the program has since been transferred to the Polytechnic Institute of New York.

Physics

PROJECT TITLE: EXPANSION OF AAPT PRODUCTS AND SERVICES

PROJECT DIRECTOR: A. A. Strassenburg

PROJECT ADDRESS: American Association of Physics Teachers
Drawer AW
Stony Brook, New York 11790

PURPOSE:

The American Association of Physics Teachers believes that it has an obligation to provide leadership in the area of instructional improvement through the stimulation of educational experiments and the management of cooperative projects as well as through dissemination of results in journals and at meetings. We are attempting to play this role by expanding the scope of our committee structure and by providing staff support for the work of committees and for the activities of our regional sections.

AUDIENCE:

Our audience are the members of AAPT. This includes most college physics teachers and a significant fraction of the high school teachers in the United States. We have evidence that documents produced by our committees and staff reach one to ten thousand of our members. We believe that published articles suggesting various new teaching approaches influence even larger numbers of science teachers.

INNOVATION:

There is nothing terrifically innovative about our project. However, it may represent one of the most serious efforts ever made by a membership organization to encourage instructional innovation among its members and to provide services to an array of teachers with complex and divergent needs.

EVALUATION:

We continuously accept and analyze feedback from our members on all our activities. Specific feedback mechanisms include the following:

1) A "letters to the editor" column is run in all three of our periodicals. Criticisms of and praise for our various projects receive serious consideration by the officers.

2) A rap session has been scheduled for the annual meeting. Officers will personally respond to comments and complaints of members.

3) Feedback forms will be distributed to all members at the annual meeting.

4) A questionnaire was sent to every member along with the annual dues bill. About 5,000 of these were returned and are now being analyzed. In addition to data on membership characteristics, we asked for evaluations of our new committee structure and the various Executive Office programs.

MATERIAL:

We have produced several documents which we believe are valuable to our members:

1) Apparatus for Physics Teaching, a book of reprints of important articles on apparatus that have appeared in The Physics Teacher magazine.

2) "A Report of a Workshop on Minicourses in Physics."

3) "Guide to Innovations in Physics Teaching," a three-volume set of brief descriptions of teaching innovations designed to stimulate communication among innovators.

4) A quarterly newsletter about physics in the two-year colleges.

5) A film repository: an outlet for the creative efforts of amateur film makers.

PROBLEMS:

We have encountered severe difficulty in obtaining consistent performance by our committees. It appears that it is not possible for busy teachers to devote an appreciable amount of time to society activities. We still feel that member participation is important to the quality and acceptance of our programs and products. However, stronger leadership, more sharply focused goals, and more structured committee procedures may improve our results in the future.

ADDITIONAL COMMENTS:

We feel that it is important to explore the extent to which membership organizations can influence the improvement of instruction. Past evidence indicates that without centralized evaluation and stimulation of new teaching methods, change occurs very slowly. Membership organizations have access to the most effective channels of communication, and thus are in a favorable position to influence instruction favorably.

Multidisciplinary

PROJECT TITLE: FILMS ABOUT SYMMETRY

PROJECT DIRECTOR: Judith Bregman

PROJECT ADDRESS: Polytechnic Institute of New York
Brooklyn, New York 11201

PURPOSE:

The project involved the preparation and evaluation of two films about symmetry. Our broad purpose is to find ways to reach new audiences for whom our usual presentations are not effective. The films are

"Symmetry" - 10 minutes, color, sound. Available from Contemporary Films/McGraw Hill for rental and sale.

"Aspects of Symmetry" - 18 minutes, color, sound. Distribution not yet arranged. Borrowable from me.

AUDIENCE:

They were planned for college undergraduates. "Symmetry," which has music but no narration, can and has been shown to people of all ages and almost any background. "Aspects of Symmetry," with narration, is appropriate at high school or introductory college level.

INNOVATION:

There are several interconnected facets to the innovative aspects of the project. There was close and extended collaboration between film designer and scientists while planning each film. Both the willingness and the resources to exploit the potentialities of the film medium freely and fully were present. The film "Symmetry," presenting a bit of mathematics in the language of an artist, has integrity both as a teaching aid in mathematics and the sciences and as an art film.

EVALUATION:

The evaluation procedure was informal. The films, when new, were shown to groups of scientists and teachers, and made available on loan. Since then they have been borrowed extensively. I have reports on how they were used, how the audience responded, and how the person who borrowed them would suggest using them.

MATERIALS:

See film titles under PURPOSE above.

ADDITIONAL COMMENTS:

The collaboration between film designers and scientists merits further comment. The process takes time; creating significantly new material cannot be done on a crash basis. Consequently funds are needed for designer's time to plan a film, not just to produce it. In addition, the process of working with people from other disciplines, and answering the questions they ask, bring fresh views of well known territory and sometimes new ways of presenting it.

Physics

PROJECT TITLE: HISTORY OF PHYSICS LABORATORY
PHYSICS: HISTORY OF SCIENCE

PROJECT DIRECTOR: S. Devons

PROJECT ADDRESS: Columbia University and Barnard College
New York, New York 10027

PURPOSE:
Supplementary to formal instruction. Emphasising the creation of scientific knowledge rather than its final form or content.

AUDIENCE:
College science teachers and students--both non-scientists and those specializing in science.

INNOVATION:
Close juxtaposition of experimental and historical approaches.

EVALUATION:
Reactions of students to courses developed here over the past four to five years. Reactions of teachers at Summer Institutes; Lectures, Seminars, etc., at Columbia University and elsewhere.

MATERIALS:
Documentary and Laboratory materials mainly for use locally. Some, published and unpublished, materials available on request.

PROBLEMS:
Presenting the historical background in an intellectually honest yet compact and accessible format.

Political Science

PROJECT TITLE: INTERNATIONAL RELATIONS PROGRAM

PROJECT DIRECTOR: William D. Coplin

PROJECT ADDRESS: Syracuse University
Syracuse, New York 13210

PURPOSE:

To develop and disseminate basic undergraduate learning packages in international relations.

AUDIENCE:

Primary emphasis on freshman and sophmore level undergraduates at two-year and four-year schools; secondary emphasis on upper level undergraduate and graduate education. Sixteen packages are now in test editions and are enjoying a great demand. Ultimately, the entire set of fifteen packages might sell 30,000 copies a year.

INNOVATION:

At the development level, the primary innovation is the fact that we conducted a nation-wide competition in which a board of outstanding scholars selected the proposals for packages from about 75 submissions. At the dissemination level, the project has stimulated the growth of a consortium to test and train faculty to use the materials. The consortium provides an ongoing structure that will serve to improve the existing packages and to develop new packages after the grant money runs out. It will also provide a broad base for dissemination since the consortium operates out of the major professional organization in the field, the International Studies Association.

EVALUATION:

A set of evaluation forms were developed for the board of scholars to use in selecting the proposals to be funded. A series of formative questionnaires are now being used on instructors and students for those involved in the field tests. Also, scholars in the field who have research reputations are asked to evaluate the package relevant to their expertise for scholarly quality.

PROBLEMS:

No major problems exist except that some of the packages are too large and complex. This may be a result of providing $1,000 honoraria. If I had it to do over again, I would have attempted to force smaller subjects on those making the proposals and would have offered about $250. However, at the time in which the project was designed, there appeared to be a need to define broad subjects and to provide a hefty honorarium. The broad subjects were necessary because of the lack of consensus on the organization of the discipline while the big honoraria appeared necessary to attract sufficient attention. Therefore, even though the packages we now have may have suffered from those early decisions, the success of the project might have been less substantial if more constraining parameters had been implemented at the beginning.

ADDITIONAL COMMENT:

Of the sixteen packages that are funded, fourteen are to political scientists, one to a sociologist, and one to a geographer. Of those making requests for the material about 80% are political scientists, with the rest coming from historians, economists, and sociologists.

Mechanical Engineering

PROJECT TITLE: A NEW PROGRAM IN MECHANICAL ENGINEERING DESIGN

PROJECT DIRECTOR: Hinrich R. Martens

PROJECT ADDRESS: Department of Mechanical Engineering
State University of New York at Buffalo
Buffalo, New York 14214

PURPOSE:

A graduate program in Mechanical Engineering Design has been developed. This program directed at the M.S. level, consists of four new core courses, four elective courses and a project oriented thesis.

AUDIENCE:

Graduate students in Mechanical Engineering with an interest in design. The program is in its second year of operation. It can be considered 90 percent operational.

INNOVATION:

The program's distinguishing features are its overall objective and the four new courses. Recent changes in national priorities have indicated a need for greater emphasis on design oriented graduate education. The need for Ph.D.'s with theoretical training has been sharply reduced, particularly in the teaching field. On the other hand, the demand for M.S. graduate engineers with a design orientation has become significantly stronger. Therefore, the objective of this new program is to enable our Mechanical Engineering Department to effectively contribute to supplying this new demand for design oriented M.S. graduates.

EVALUATION:

The program has been evaluated by exposure to graduate students over a two-year period. Approximately 35 students have been involved in taking the new courses.

MATERIALS:

Materials developed consist of course outlines, a package of computer programs for design optimization, and bibliographies of reference texts. These are available by writing to the project director.

PROBLEMS:

The most serious problem appears to lie in the recruitment of a competent design oriented faculty member. The market is extremely tight and the "ideal" person seems to be unavailable. We have been looking for two years now.

ADDITIONAL COMMENTS:

The development entailed the establishment of four new courses: Modeling of Physical Systems, Modern Material Selection and Usage, Optimization in Engineering Design, and Computer Aided Design. In addition, a Design and Prototype Laboratory is to be created. It will serve as central experimental proving ground for testing of concepts and techniques presented in the four courses, thus bonding the four design courses together.

Multidisciplinary

PROJECT TITLE: NEWSPAPER OFFERING OF COURSE ON MAN AND TECHNOLOGY

REPORTED BY: Dr. John G. Truxal
College of Engineering and Applied Sciences
SUNY at Stony Brook
Stony Brook, New York 11794

PURPOSE:

To demonstrate utilization of the newspaper as a communication medium for delivery of educational programs in scientific and technology literacy.

AUDIENCE:

The plan is to publish the core material weekly in the 400,000 copies of The New York Times which are delivered to Long Island. The audience is this population (primarily adults), plus a smaller group of advanced secondary school and college students. Credit for the course will be offered by SUNY at Stony Brook and any other Long Island colleges wishing to participate.

INNOVATION:

In contrast to the San Diego experiment, fully half the educational material will actually be in the newspaper.

EVALUATION:

The newspaper will conduct readership surveys and analyses. The students will be given exams analogous to those given to on-campus undergraduate and adult-education students.

MATERIALS:

Materials are now being developed for the newspaper content and also for kits for students. These will be available, when completed, from the College of Engineering at Stony Brook and, if successful, eventually commercially.

PROBLEMS:

By far the most serious problem is the difficulty of working with and obtaining agreement of the newspaper personnel and management. This difficulty was anticipated, but not in magnitude. It is natural since the newspaper personnel have constraints which we did not recognize until well into the discussions and planning.

Multidisciplinary*

PROJECT TITLE: PEST POPULATION ECOLOGY: AN INTER-UNIVERSITY EDUCATIONAL PROGRAM

PROJECT DIRECTOR: David Pimentel

PROJECT ADDRESS: Comstock Hall
Cornell University
Ithaca, New York 14850

PURPOSE:

Objective of this educational program is to train ecological specialists who can actively participate in pest management projects to assess the parameters of an ecological situation and to work out environmentally sound methods to solve the problems.

AUDIENCE:

M.S. and Ph.D. graduate students. Several students have graduated and are actively involved in ecologically oriented pest management projects for government, universities, and industry.

INNOVATION:

Three aspects of the project were innovative: (1) Use of faculty from 5 different universities to offer jointly, a single training program; (2) Exchange of graduate students between participating institutions; and (3) Training ecology students to deal with practical environmental problems.

EVALUATION:

Perhaps of greatest significance has been the fact that in the institutions in which the faculty teach, major curricula revisions have been made as a result of these ecological pest management programs. The success of our program also is reflected in the numerous requests for the joint faculty to participate in conferences concerned with ecology and pest management.

MATERIALS:

The course curricula and programs were developed jointly by the 5 cooperating faculty.

PROBLEMS:

The most serious difficulty was working out a suitable exchange program for students to move between participating institutions.

* Ecology, entomology, mammology, ornithology, genetics.

Multidisciplinary

PROJECT TITLE: A PROJECT TO BUILD EDUCATIONAL BRIDGES BETWEEN SCIENCE AND THE HUMANITIES

PROJECT DIRECTOR: V. L. Parsegian

PROJECT ADDRESS: Rensselaer Polytechnic Institute
Troy, New York 12181

PURPOSE:

To develop teaching materials that interrelate the sciences and the humanities and fine arts.

AUDIENCE:

Third or fourth year students of any college level program, including engineering, social science, humanities, education or art majors.

INNOVATION:

Developing themes that are of philosophical as well as of scientific, historical nature, relevant to current societal issues and promoting of dialogue between students from different disciplines.

EVALUATION:

Discussions with colleagues from various disciplines, and their review of the draft of text material developed to this date. Also, I have used some of the principal themes in lectures to audiences of faculty and students whose backgrounds were mostly in non-science areas.

MATERIALS:

A draft of the first twelve chapters of the book has been read by many people, with good reactions and many suggestions for improvements.

PROBLEMS:

The difficulty of multidisciplinary studies and writing. Even under the best circumstances the burden falls heavily on one pair of shoulders to draft and integrate materials. There is no way to make such projects easy, but adequate funding to include help for continuing reviews and criticism improves the product.

ADDITIONAL COMMENTS:

Please continue to support multidisciplinary struggles such as this, and support of summer programs that help to prepare potential users of the products of such struggles.

As to particular groups to be helped, I consider the faculty and curricula of schools of education, which prepare potential teachers for lower level schools, to be our most urgent problem area.

Entomology - Applied Ecology

PROJECT TITLE: MASTER'S TRAINING IN INSECT PEST MANAGEMENT

PROJECT DIRECTOR: R. L. Rabb

PROJECT ADDRESS: North Carolina State University
Raleigh, North Carolina 27607

PURPOSE:

To provide an educational experience and training at the graduate level conducive to successful careers in insect pest management. (Pest management is the selection, integration, and implementation of pest control actions on the basis of predicted economic, ecological, and sociological consequences.) Man is a part of rather than apart from the world ecosystem. Insects (over 1 million species) are essential to a viable ecosystem and thus should be viewed as a natural resource. Those insects designated as pests (only several hundred out of over one million species) in general should be managed according to sound ecological principles rather than eradicated. Obviously, this philosophy is incompatible with the public's poorly conceived notion of a pest-free environment. Because of the complexities of developing these systems, advanced training is necessary for the personnel involved.

AUDIENCE:

Three categories of graduates: (1) those who can implement the research necessary for the development of pest management programs; (2) those who can work with existing extension personnel, rural and civic organizations, and private citizens in implementing the programs developed; and (3) those who have the qualifications for further study leading to Ph.D. degrees and positions of leadership in research and extension.

INNOVATION:

Increased emphasis has been given to ecology as the basic discipline undergirding pest management. Since pest control comprises but one subsystem in systems designed to produce agricultural or forest products or to provide desirable living or recreational areas, and interactions among the various subsystems involved are of importance to the realization of end objectives, more attention has been focused on the integration of expertise from the various disciplines involved. Thus, the systems perspective has been developed in the training program and the economic, sociological, and political implications of optimal control programs have been stressed.

EVALUATION:

There has not been a formalized evaluation to date. My intuitive feeling is that our project has strengthened our graduate program in applied ecology but that certain facets of the program should be modified. Ecological problems such as those associated with pest control are becoming more critical and complex each year. Consequently, the development of better pest management systems and the training of pest

management specialists must pro[redacted]taneously. The experience gained in this project should provide an excellent basis for a much improved program in the future, provided support is available. Since only one of the five trainees has completed the program, it is difficult to assess its impact at this point in time.

MATERIALS:

None

PROBLEMS:

Selecting qualified trainees. Research in pest management must be accomplished in large measure in the field. It requires a high level of intellectual competence, but also much hard work and the ability to communicate effectively with farmers and other laymen. Therefore, personality and motivation as well as academic ability are critical attributes. We did a fair job of selection, but must do better in the future. Another problem was to devise a means for giving students adequate experience in evaluating pest problems and in making decisions regarding actions to be taken under varying field conditions. We have made some progress in providing this experience through Special Problems courses and cooperative arrangements with Extension personnel. In the future, we shall place more emphasis on selecting trainees who have a sincere interest in field research and who have the personality and motivation to work with people. Such individuals must have the courage and ability to make decisions on the basis of what is scientifically feasible and economically and socially desirable and practical.

Social Science

PROJECT TITLE: PROGRAM IN THE HISTORY OF THE SOCIAL SCIENCES

PROJECT DIRECTORS: Craufurd D. W. Goodwin
Neil de Marchi

PROJECT ADDRESS: Duke University
Durham, North Carolina 27706

PURPOSE:

We have been engaged for four years in an interdisciplinary graduate program for sociologists, political scientists and economists, with three purposes in view:

(1) To give students an historical perspective in respect of their own discipline. More specifically, we have sought to make them aware of the dangers of blindly accepting without question the current dogma.

(2) To open students' minds to past and potential patterns of interdisciplinary cross fertilization and their bearing on the advance of social science.

(3) To make students aware of some of the implications of the professionalization of the social science disciplines (for example, the problems associated with advocacy).

AUDIENCE:

We have addressed ourselves almost exclusively to students with two years of graduate training behind them. Given our aims this seems to be the most appropriate point at which to introduce students to the program. We presume some knowledge by students of philosophy of science and of the development of their own discipline.

INNOVATION:

Any novelty which attaches to our program lies chiefly I suspect in our attempt to lead students into a working understanding of tools, concepts, attitudes and approaches with which they would normally not come into contact in the course of their single-discipline professional training. For example, we have explored the applicability to the social sciences of the so-called "new historiography of science" and some of the critical discussion arising out of it (e.g., the writings of Kuhn, Lakatos and Toulmin). Again, students are introduced to the notion of science as the work of a series of communities, some of the simple ways of capturing community structure and functioning (e.g., communications networks and invisible colleges, the use of citation data to get at changing commitments) and some of the normative aspects of community functions as they affect the progress of science (the refereeing process, for instance).

EVALUATION:

Without attempting a formal evaluation, our judgement is that the program has served students better in the way of stimulating and broadening them than it has as an integrative effort.

PROBLEMS:

Two problems are encountered with every fresh class. The first, which is relatively easily overcome, is the typical lack of historical perspective or historical analytical experience in contemporary students in the social sciences. The second relates to the lack of a common framework of language and mental bent in students from the three participating disciplines.

The format adopted has been designed to cope in some measure with these difficulties. To give students the experience of tackling an historical problem, we require of each a substantial paper, representing original research. These are developed in collaboration with the director of the seminar (conducted each spring semester) and/or some other participating member of Faculty. We have also used the program as a base for launching related causes within the departments of political science and economics, to give those entering the interdisciplinary seminar a more adequate background in the historical development and methodology of their own discipline. To get at the second source of difficulty we have tried (a) to work within an analytical framework derived not from any one of the three specific disciplines we are concerned with, but from philosophy of science, and (b) to make the seminar function as a workshop to identify differences and failures of communication and to reach a working consensus.

Life Sciences: Plant Sciences

PROJECT TITLE: COURSE IMPROVEMENT IN THE DEPARTMENT OF BOTANY

PROJECT DIRECTOR: Charles Heimsch

PROJECT ADDRESS: Department of Botany
Miami University
Oxford, Ohio 45056

PURPOSE:

In 1971 the basic curriculum requirement at Miami University was changed. Changes of particular significance for science departments were the reduction of the science requirement from two years to one year, the encouragement of topical introductory courses as alternatives to those of a survey character, particularly for non-science majors, and the general allowance of credit for single quarter units of a year sequence. In response to the changed requirements, the Department of Botany modified its elementary offerings markedly. The Instructional Scientific Equipment Grant, now in its second year, was aimed to supply equipment items to aid in achieving maximum effectiveness in the revised introductory courses.

The basic purpose of course improvement centered on providing broader laboratory experiences. These were directed toward enabling more complete class participation in experimental exercises, to the introduction of experiments that could not otherwise be performed, to support identification courses with microscopes, and to provide equipment for a new course, Environmental Analysis.

AUDIENCE:

The audience comprises both major and non-major students. Numbers of students thus far affected are:

	1972-73	1973-74
General Botany	167	162
Trees and Shrubs	114	107
Spring Flora	192	--
Environmental Analysis	--	20
Plant Physiology	50	51

INNOVATION:

Some of the experiments and opportunities to use different types of equipment are probably unique to the General Botany course. The course in Environmental Analysis, which is a corollary to environmental courses offered in several departments, is certainly somewhat unique in affording actual practice and experience in evaluating a range of conditions prominent in assessing environmental quality. This course is also somewhat unique in being cross-listed with the Physics Department. More fundamentally, the entire program is unique in offering an option among various topical courses as an introductory experience.

EVALUATION:

None has been made since the objectives have little bearing on evaluation. If the criterion of enrollment is considered, though, the program and individual courses must be considered to be successful.

MATERIALS:

The only materials developed are guides for new laboratory exercises in General Botany and Plant Physiology and the laboratory procedures for Environmental Analysis. Examples are on display.

PROBLEMS:

The objectives were not of a nature to involve any problems.

ADDITIONAL COMMENTS:

The new elementary course offering supported by the equipment grant must be considered as successful. Some directions or trends are suggested for posiible consideration in other institutions. These are set forth in copies of an address concerning the curriculum. Limited copies are available.

Multidisciplinary

PROJECT TITLE: ERIC CENTER FOR SCIENCE, MATHEMATICS AND ENVIRONMENTAL EDUCATION

PROJECT DIRECTOR: Robert W. Howe

PROJECT ADDRESS: ERIC Center for Science, Mathematics, and Environmental Education
The Ohio State University
1800 Cannon Drive
400 Lincoln Tower
Columbus, Ohio 43210

PURPOSE:

National information Clearinghouse to (1) identify, select, abstract, and index materials for ERIC publications; (2) produce research reviews, directories, program descriptions, and other publications as needed; (3) to provide assistance to the public in the use of the ERIC system; and (4) maintain information bases to improve education.

AUDIENCE:

All people have access to most of the information in ERIC through ERIC publications. Additional information and assistance is provided as we are able on a "no charge" basis. Some extensive assistance is done on a contract basis.

ERIC/SMEAC and the Center for Science and Mathematics Education served approximately 20,000 requests for information last year (1973).

INNOVATION:

Provides an ongoing information system with both current awareness and retrospective search capability. Other aspects of ERIC/SMEAC's program include developing data bases related to our areas to permit analyses of changes in school programs, teacher characteristics, teaching problems, etc.

EVALUATION:

We have used extensive surveys to determine user evaluation of services and products. We have also analyzed unsolicited responses from the field (positive and negative) regarding the program. The Office of Education has funded a number of evaluations of the ERIC system and ERIC products.

MATERIALS:

Copies of "How to Use ERIC" and publication lists will be distributed.

PROBLEMS:

Most serious problem is limited funds available for publications, workshops on how to use ERIC, and providing user services. Demand far exceeds ability to respond at a level people desire.

Mathematics
(Numerical Analysis)

PROJECT TITLE: FILM PROJECT IN NUMERICAL ANALYSIS

PROJECT DIRECTOR: George H. Andrews

PROJECT ADDRESS: Oberlin College
Oberlin, Ohio 44074

PURPOSE:

In our project, we produced a "first approximation" to a videotaped course in elementary numerical analysis.

AUDIENCE:

The course package is designed for students with the background of at least a year of calculus and a short course in computer programming. The particular language is not important, but we happened to use Fortran.

INNOVATION:

The primary motivation for our experimentation lies in the hope that the course package can be used to improve the quality of instruction. The overriding purpose was to stimulate more student-teacher interaction by freeing the lecturer of the task of preparing and delivering systematic lectures of a factual nature. The videotapes provide a pace and emphasis that is not possible within the confines of a textbook alone. In fact, such guidance can be helpful to the instructor as well if his or her experience is limited in the field.

EVALUATION:

The reactions to the tapes in the ten institutions which have used the course in part or entirely have been mixed. No formal uniform evaluation procedure was developed, but each institution was asked to provide us with some sort of reaction. It is fair to say that where the course has been used as intended, the reactions have been favorable.

MATERIALS:

The course package includes 32 videotapes containing 64 lectures each of about 25 minutes duration. In addition, we produced a set of supplementary notes (563 pages) designed to relieve the viewer of note-taking as well as provide exercises, programming problems, instructional help, and bibliographical references.

PROBLEMS:

If we were to do it again we might try to take some of the burden from the single lecturer by involving a second person in a supportive way.

Multidisciplinary

PROJECT TITLE: NONE

PROJECT DIRECTOR: R. L. Lowery

PROJECT ADDRESS: Oklahoma State University
Stillwater, Oklahoma 74074

PURPOSE:

The purpose is to develop a program of "professional practice", or internship, in conjunction with our new Master of Engineering degree program that places emphasis on professionalism and a real time engineering experience prior to the last semester of the program.

AUDIENCE:

We currently have approximately 20 fifth year students in internship at various companies. We hope to reach a final rate of 100 interns per year.

INNOVATION:

The major innovation is that of using experienced company engineers as preceptors or "adjunct" professors to assist the faculty in the professional practice experience. The interning student is required to prepare a substantial report which is defended after he returns to campus for the last semester. Course credit is awarded only after the participating company and the faculty have certified the quality of the work.

EVALUATION:

The evaluation of the program will require a long period of time. The main figure of merit will be the acceptance of the participating industries and, of course, the marketability of the graduates.

MATERIALS:

No specific materials are being developed other than documentation of policies and procedures and the clarification of method for establishing professional practice in engineering education.

PROBLEMS:

The most serious obstacle is the low undergraduate enrollment. Strong competition exists for all available students from the professors with contract research. Hence sending a student off-campus for an internship removes him from the research labor pool. The other problem of note is one of learning how to assess the educational potential of a given company. Some firms provide excellent experience but others supply only minimal direction and learning opportunities.

Meteorology

PROJECT TITLE: ENGINEERING METEOROLOGY COURSE DEVELOPMENT

PROJECT DIRECTOR: Amos Eddy

PROJECT ADDRESS: University of Oklahoma
Norman, Oklahoma 73069

PURPOSE:

This introductory graduate level course endeavours to demonstrate to the potential decision makers of our society that objective methodologies exist for the evaluation of probable consequences of their decisions.

AUDIENCE:

Up until now the audience has been beginning graduate student/senior level undergraduates of meteorology on campus. Plans are underway to teach this as one of a set of urban-oriented courses across our state wide, closed circuit, talk-back TV system. Decision makers in the Tulsa Metropolitan Area Planning Commission (TMAPC) are interested and already cooperating by supplying ideas and data.

INNOVATION:

So far this has involved only the use of real data in programs run by the students on our departmental computer. Experiments involving the in-class use of this computer in conjunction with the televised lectures is being investigated. TMAPC personnel have expressed an interest in active (remote) in-class participation.

EVALUATION:

Simply discussions with students after the course is over and observation that the techniques have carried over into their research. The regular "outside" evaluation will be carried out as required.

MATERIALS:

Computer Programs and Lecture Notes. These will be available in the early spring of 1974 from the author.

PROBLEMS:

Trying to teach the use of real data, laboratory exercises and the basic theoretical concepts in one semester -- nothing unusual. Has been taught two ways: a) problem oriented, and b) theory oriented. The former has had the most apparent success.

ADDITIONAL COMMENTS:

Longer term NSF support would be useful for production of the most efficient results.

Metallurgy and
Materials Science

PROJECT TITLE: COMPUTER APPLICATIONS TO PHASE DIAGRAMS
A PEDAGOGICAL TOOL FOR THE TEACHING OF METALLURGY AND MATERIALS SCIENCE

PROJECT DIRECTOR: C. H. P. Lupis

PROJECT ADDRESS: Carnegie-Mellon University
Pittsburgh, Pennsylvania 15213

PURPOSE:

The purpose of this project is to improve the teaching of thermodynamic concepts associated with phase diagrams through the development of new computer-supported pedagogical tools.

AUDIENCE:

These are primarily aimed at college students in their junior year, but should also be useful to seniors and first-year graduates, in disciplines such as metallurgy and materials science, chemical engineering, chemistry and geology.

INNOVATION:

Software packages have been developed to compute phase diagrams and related thermodynamic functions using solution models developed in course work. Designed to supplement the traditional classroom lecture approach, the software may be used by inexperienced students in a strongly supportive, interactive mode.

EVALUATION:

The software packages have been used by undergraduate students at Carnegie-Mellon as part of their classwork assignments with very satisfactory results, and feedback from these experiences have served to improve the packages.

MATERIALS:

A very basic instruction manual in a semi-programmed learning format has been written to facilitate the use of the programs and of a graphic display terminal. A silent 16 mm color movie of animated sequences is being produced to illustrate and emphasize some of the important thermodynamic concepts contained in the software packages. The movie is based on actual computer generated graphic output. In addition to its usefulness in its own right, the movie will complement pedagogically the software packages by motivating the students to explore by computer various features of thermochemistry through suitable choice of input parameters. The software packages as well as the movie will be available from Carnegie-Mellon University at nominal costs. Special efforts have been made to design the software programs in ways which minimize computer costs.

PROBLEMS:

Most of the difficulties encountered have been in the debugging of the programs, the occasional unavailability of Carnegie-Mellon University's main digital computer because of overload and hardware failures, and in the technical cinematic details associated with the production of the movie. These difficulties have slowed the progress of the project but are being overcome. Interest expressed in the project by university professors in the United States and abroad has been very gratifying.

Information Science

PROJECT TITLE: CURRICULUM DEVELOPMENT IN INFORMATION SCIENCE AND ITS EVALUATION

PROJECT DIRECTOR: Jack Belzer

PROJECT ADDRESS: University of Pittsburgh
Pittsburgh, Pennsylvania 15213

PURPOSE:

The purpose of this research is to develop curricula in Information Science and provide guide lines for schools who wish either to reexamine their programs or develop new ones.

AUDIENCE:

The audience consists of information scientists, educators and University administrators throughout the world.

INNOVATION:

Questionnaires were used to gather data about ongoing programs and workshops of deans, program directors, faculty and industry and government representation, to elicit what they think should be offered and identify the gaps. One of the workshops was a Delphi Method for eliciting such information.

EVALUATION:

Industry, government, and educational institutions were called upon to identify jobs, functions and tasks at various levels to be performed by graduates and/or professionals in information science. The degree to which the preparation of graduates in the program to enable them to take on these assignments was a way to evaluate programs.

MATERIALS:

The materials developed through the efforts of this research are curricula in information science by course titles, content descriptions, topic clusters and identification of interdisciplinary areas. Also developed were methodologies for obtaining and analysing such data. Special techniques in Cluster Analysis and a new application of the Delphi Method were direct results of this research.

PROBLEMS:

Having faculty respond to questionnaire data were the most difficult aspects of the project, because this was an exhaustive study rather than a sampling process. Results were obtained basically on a personal basis by sugared arm twisting.

ADDITIONAL COMMENTS:

There is still a great deal to be done in this area, and there will be until the field gets stabilized more than it is now.

Materials

PROJECT TITLE: SINGLE CONCEPT FILMS ON MATERIALS SCIENCE AND ENGINEERING

PROJECT DIRECTOR: Herbert A. McKinstry

PROJECT ADDRESS: The Pennsylvania State University
University Park, Pennsylvania 16802

PURPOSE:

The purpose of this project is to provide short, limited concept, instructional films for materials science and engineering at the upper class level of undergraduate education. The films are designed to be used both in the traditional classroom setting by the instructor and in a personalized system of instruction by the student.

AUDIENCE:

The films are intended for undergraduates at the sophomore or junior level, particularly for those in an introductory course on materials science. A background of introductory college physics and chemistry is assumed. However, for the smaller colleges which do not have courses in materials science, instructors in physics, chemistry, geology, and other disciplines would find the films useful in more advanced courses.

INNOVATION:

Three separate and distinct producing groups are involved in the production of the films: The Pennsylvania State University Motion Picture Services; an independent nonprofit producing agency; a commercial producer. This arrangement is intended to offer NSF a comparison of cost and quality in instructional film production.

Another innovative feature of the project is the development of a technology and expertise in computer animation for full color film production. The project director and his associates have received two invitations to make formal presentations of this aspect of the work. A published paper on this part of the project will appear in 1974.

EVALUATION:

The films have been evaluated at various stages of development by a national advisory committee. Members of the committee include some of the country's leading materials scientists as well as faculty of other disciplines from both small colleges and large universities. The committee has monitored the selection of topics, the preparation of scripts and story boards, and the films themselves at work print and answer print stages. When they are released, sometime in 1974, members of the committee and others will be asked to evaluate the films in typical teaching-learning situations with their own students. Later, after the films are in use, the project leaders will check the utilization semiannually and obtain evaluative feedback on a selective basis.

MATERIALS:

When completed the project will make available 14 sound films in 16 mm and Super 8 cassette formats, and 4 silent films in the Super 8 cassette format only. The films will be accompanied by manuals containing descriptions of the film's content, suggestions for use, some additional technical background material and bibliographical data. Three general topical areas will be represented with 4 or 5 films in each area. The general subject areas are Phase Equilibria, Strength and Deformation of Solids, and Electrical Characterization of Materials.

PROBLEMS:

The most serious difficulty encountered arose from the division of film-making responsibility among three separate producers. This feature of the project put both script development and film production at some distance from the control and oversight of the prime contractor and resulted in delays in progress and completion. In one case, serious discontinuity occurred with the result that the prime contractor was obliged to assume additional film production responsibility in order to fill the gaps.

ADDITIONAL COMMENTS:

In retrospect it now seems that an additional function might well have been added to the project. This would have provided for a conference and workshop to develop the application and utilization of the films to undergraduate education. As a part of such a program, modules for a personalized system of instruction would be developed on a pilot basis in which the films would be integrated as media support materials. This still could be accomplished, of course, by way of a follow-up project.

Furthermore, it is obvious that the most important step in the use of media support materials is an active (if not aggressive) nonprofit marketing strategy. The materials must be available from one media center. They must fit rather simply and easily into regular units or parts of typical courses, and so on. Media production can come from many sources, but since the market is small and of little interest to commercial distributors, a nonprofit media center appears to be mandatory. Such a center can not only provide for adequate distribution and utilization but also can serve to promote the interests of educational technology in general.

Mathematics
Computer Science

PROJECT TITLE: TOPOLOGY FILM PROJECT

PROJECT DIRECTOR: Nelson Max

PROJECT ADDRESS: Department of Mathematics
Carnegie-Mellon University
Pittsburgh, Pennsylvania 15213

PURPOSE:

The goal of the project is the production of a series of computer animated films showing concepts in topology which could not be effectively communicated except by film.

AUDIENCE:

The films are addressed to college audiences.

INNOVATION:

The chief innovation is the use of the computer to draw the changing curves and surfaces, which are quite complex in several scenes, and are slightly different for each frame of the film.

EVALUATION:

The first film was tested in a preliminary version, and over 800 questionnaires were returned, resulting in significant and expensive changes in the final version.

MATERIALS:

The first three films are presently available from the Education Development Center in Newton, Massachusetts, with permanent distribution expected to be by the International Film Bureau in Chicago, Illinois.

PROBLEMS:

My most serious difficulty at present is in interactively inputting to the computer the surface I wish it to draw. If I had a chance to do the project over, I would not have spent as much time and money revising the first film. In any case, the suggestions and "meddling" of the N.S.F., both in the proposal and during the project itself, were particularly useful in assuring the final results.

Multidisciplinary

PROJECT TITLE: Department of Physics

PROJECT DIRECTOR: Jerome L. Duggan

PROJECT ADDRESS: North Texas State University
Denton, Texas 76203

PURPOSE:

The purpose of the project is to develop laboratory manuals and instructional material for advanced laboratories in science. These experiments are designed to introduce "state of the art" nuclear techniques into advanced science laboratories.

AUDIENCE:

This material is being developed primarily for juniors and seniors in the following disciplines: physics, chemistry, biology, geology, and environmental sciences. So far, a preliminary version of a chemistry, physics nuclear manual has been written and is being field tested in approximately 24 universities. The potential audience for the four manuals that will be written are universities throughout the country that are interested in upgrading their advanced nuclear offerings in the laboratory.

INNOVATION:

The innovations in this project are primarily the fact that some of the instruments that are being used have just recently been developed for educational use. Our goal is to introduce new ideas and techniques straight from the research laboratory, modify the approach and adapt the experiment for the undergraduate laboratory. Innovations in senior projects which use nuclear techniques to solve environmental problems are also outlined.

EVALUATION:

The instructional material that is developed as a result of this project is being field tested in 24 university laboratories throughout the United States.

MATERIALS:

A chemistry-physics manual has been written and is available to any university science department that can show a need for same.

PROBLEMS:

The project has not experienced any major difficulty.

Electrical Engineering

PROJECT TITLE: DEVELOPMENT OF LASER EXPERIMENTS FOR UNDERGRADUATE STUDENTS

PROJECT DIRECTORS: M. Kristiansen and M. O. Hagler

PROJECT ADDRESS: Department of Electrical Engineering
Texas Tech University
Lubbock, Texas 79409

PURPOSE:

To develop application oriented undergraduate laser experiments that can demonstrate, at a low cost, the practical advantages of lasers.

AUDIENCE:

Primarily undergraduate electrical engineering students, but also other engineering and physics students. We are presently running off the third printing of our reports. We have received requests for copies from about 60 United States and 10 foreign engineering and physics departments and have received many favorable letters of comments.

INNOVATION:

We demonstrated that it is possible to carry out a wide series of relatively sophisticated and realistic laser experiments at an investment cost below $2000.

EVALUATION:

The project was primarily evaluated in terms of 1) Enthusiastic response by our own students, 2) Large number of requests for copies of our reports and many favorable letters of comments, 3) Solicited letters of opinions from noted laser experts.

MATERIALS:

Wrote two detailed reports (400 pages) describing the necessary equipment, experimental set up, theory, and typical results for a total of 19 experiments. Published 4 papers on various aspects of this project in educational journals.

PROBLEMS:

We had no special problems and just thoroughly enjoyed the entire project.

PUBLICATIONS:

1. L. N. Peckham, M. O. Hagler, and M. Kristiansen, Technical Report No. 1 on NSF Grant GY-4761, June 16, 1969.

2. G. M. Molen, C. R. Parten, M. O. Hagler, and M. Kristiansen, Technical Report No. 2 on NSF Grant GY-4761, May 1971.

3. L. N. Peckham, M. O. Hagler, and M. Kristiansen, "Laser Experiments for Undergraduate Electrical Engineering Students," SWIEEECO Record, April 1969, 21 C.

4. L. N. Peckham, M. O. Hagler, and M. Kristiansen, "An Optical Data Processing Experiment for E.E. Students," IEEE Trans. Educ. E-13, 60 (1970).

5. L. N. Peckham, M. O. Hagler and M. Kristiansen, "Laser Laboratory Projects for Undergraduates," Engineering Education 60, 899 (1970).

6. G. M. Molen, R. H. Trotter, M. Kristiansen, and M. O. Hagler, "CO_2 Laser Design and Laboratory Projects," IEEE Trans. Educ. E-15, 51 (1972).

7. J. E. David, C. R. Parten, M. O. Hagler, and M. Kristiansen, "A Holographic Data Storage System Design Project," Internat. Journal Elect. Eng. Educ., Vol. 10, No. 4 (1972).

8. C. R. Parten, G. M. Molen, M. O. Hagler, and M. Kristiansen, "Undergraduate Laser Experiments," SWIEEECO Record, April 1970, 53.

As a fall out of this project we also published a review paper:

L. N. Peckham, M. O. Hagler, and M. Kristiansen, "Industrial Applications of Lasers," ISA Trans. 9, No. 3, 216 (1970).

Engineering

PROJECT TITLE: ENERGY SYSTEMS ENGINEERING

PROJECT DIRECTOR: E. Linn Draper, Jr.

PROJECT ADDRESS: Nuclear Reactor Laboratory
The University of Texas at Austin
Austin, Texas 78712

PURPOSE:

The graduate program aimed at producing master's level engineering graduates in Energy Systems Engineering has been initiated at The University of Texas at Austin. The aim of the program is to take students with undergraduate backgrounds in mechanical, electrical, nuclear or chemical engineering, and provide them with sufficient breadth that they can function effectively in the electric utility industry. It is felt that a student with proper educational background can enter this program, and within one calendar year, make a useful impact in the electric utility industry.

AUDIENCE:

Students entering this program all have a bachelor's degree in some field of engineering. Most are electrical or mechanical engineers who concentrate their electives in the other branch of engineering. All students who complete the program have taken at least one course in thermodynamics, electric circuit theory, nuclear engineering, engineering economics, and environmental engineering. In addition to the course work, each student is required to serve an internship on an industrial project. The projects are solicited from industry and most of the students actually do them in residence at the industry. Some students, however, chose to do the industrial project on the campus. To date, approximately a dozen students have enrolled in a program, six have completed the program; all six are now employed in industry.

INNOVATION:

The unusual aspects of this program are its industrial orientations - the fact that each student is required to perform realistic industrial problems in lieu of a master's thesis.

EVALUATION:

The principle form of evaluation is a form of consultation with industrial participants. It is our feeling that in order for the program to be a success, industries must be convinced that a student coming out of our one-year program is more valuable to them than a bachelor's degree student with one year experience. We therefore solicit their opinions of our students, and suggest that they comment to us with respect to possible modifications of the program to make it more effective.

MATERIALS:

No specific materials have been formulated for widespread dissemination. There are class notes which have been used in some of the courses. These are still in various stages of modifications, but are available to other interested universities. For class room notes, contact should be made with Dr. E. Linn Draper, Jr., Nuclear Reactor Laboratory, University of Texas at Austin, Austin, Texas 78712.

PROBLEMS:

To date the more serious problems are eliciting the cooperation of local industry. We've had very good cooperation with several national firms, including vendors of electric utility equipment. We've also had good cooperation with some firms in other states. It has taken some time, however, to convince the Texas utility industry that our product is more valuable to them than a bachelor's degree graduate with one year experience. Obviously, actually having a master's degree will command a somewhat higher salary than a bachelor's degree student.

Earth Science

PROJECT TITLE: ENVIRONMENTAL EARTH SCIENCES

PROJECT DIRECTORS: Addison Lee and Rolland Bartholomew

PROJECT ADDRESS: The University of Texas at Austin
Austin, Texas 78712

PURPOSE:

The cooperative development between the Department of Geological Sciences and the Science Education Center of The University of Texas at Austin of a new interdisciplinary course with emphasis on the earth sciences. Development of this course involves the preparation of 1) a series of multi-media lecture introductions to specific environmental earth science problems, 2) audio-visual-tutorial modules, 3) small group discussions, and 4) synthesis lectures.

AUDIENCE:

The environmental earth science course (GEO 361K--3 hrs. credit) is designed for the upper division undergraduate student with a major in education who desires to meet the academic foundation science credit of 6 hours required for graduation.

The first pilot offering of the course to 18 students was in Spring 1973. The second offering to 31 students is currently in progress (Spring, 1974).

The maximum number of students expected to take this course is approximately 200.

INNOVATION:

1) The cooperative planning, development, and administrative coordination between personnel of the Department of Geological Sciences and the Science Education Center.

2) The use of personnel trained in the Center for Communication Research in making the audio-visual-tutorial programs.

3) The excellent quality of the audio-visual-tutorial programs that have been developed.

4) The potential for sharing with others the techniques used in developing audio-visual-tutorial programs.

EVALUATION:

1) The pilot course taught in Spring, 1973, was evaluated by the Measurement and Evaluation Center by questionnaire.

2) A graduate student conducted a research study of reactions to selected audio-visual-tutorial modules. His dissertation is available for study.

3) The instructor and development staff met regularly during the Spring, 1973, semester to discuss how the course materials were working out.

4) The audio-visual-tutorial modules were critiqued during the 1972-1973 school year by a group of geology faculty and graduate students in earth science education in weekly noon seminar meetings.

5) Each audio-visual-tutorial module is undergoing revision in response to reviews conducted by geology faculty during the Summer and Fall of 1973.

MATERIALS:

Fourteen audio-visual-tutorial modules have been developed. Revision of these modules is in progress as noted in Evaluation 5. Information about the modules and release data for loan can be obtained from:

Dr. Rolland B. Bartholomew
Science Education Center
University of Texas at Austin
Austin, Texas 78712

PROBLEMS:

1) The major effort in this project up to the present time has been the development of the audio-visual-tutorial modules (AVT) and the design of study carrels in which the AVT modules are used. This work has proved to be a surprisingly complicated process because of the automated nature of the AVT modules and the desire to produce superior AVT modules.

2) Graduate students in earth science education were used as AVT authors. Faculty members of the Department of Geological Sciences were used to identify the subject content for each AVT module. This introduced two problems: a) the constant need for supervision of the AVT authors, and b) the coordination of the subject content specialists and the AVT authors.

3) Use of educational media equipment poses countless operational problems.

4) The difficulties involved in communication between the content specialists (earth scientists) and the media (communications) people who failed to appreciate the concerns for generalizations, details, etc. about the subjects covered in the AVT modules.

What has been learned?

5) Use academic faculty as AVT authors and graduate students in earth science education as consultants in designing the AVT modules.

6) Select faculty or graduate students trained in using communication media for the production of AVT modules and avoid direct involvement of media personnel except in an advisory role.

ADDITIONAL COMMENTS:

1) Underestimated the time required to produce the quality AVT modules desired. In other words, the plans as outlined in the grant proposal were overambitious.

2) Desire to develop an effective means of distributing these materials to a wider audience of potentially interested geology/science education faculties throughout the country.

Multidisciplinary

PROJECT TITLE: PROJECT C-BE

PROJECT CO-DIRECTORS: John J. Allan and J. J. Lagowski

PROJECT ADDRESS: The University of Texas at Austin
Austin, Texas 78712

PURPOSE:

Project C-BE is a four-year project with a $1.3 million NSF budget which began in January, 1972. The effort is also receiving sizeable contributions from The University of Texas at Austin. The goal is to study the effects of computer-based instruction at a typical large university.

AUDIENCE:

Under the co-direction of Dr. John J. Allan, Associate Professor of Mechanical Engineering, and Dr. J. J. Lagowski, Professor of Chemistry, the Project is the first coordinated, massive assault using computer-based techniques ever attempted at one university. Professors in many fields, including such areas as various fields of engineering, chemistry, psychology, mathematics, physics, zoology, economics, home economics, architecture, and biology are participating in the experiment. In addition to the approximately three dozen professors, 48 teaching assistants and 3,000 students in the five colleges will participate between January, 1972, and January, 1976.

INNOVATION:

Today, the typical professor is being swamped by ever-increasing numbers of students, and yet the students are very much in need of individualized instruction. With the use of the computer as a supplement to course material, the teacher can given the students much more individualized instruction, because he will have more time to actually interact with the students. Computer-based instructional techniques will assist the instructor in teaching large classes material which is more and more sophisticated. The computer is being used in both lecture and laboratory situations.

EVALUATION:

In order to make the above changes a reality, Project C-BE must accomplish four goals which the National Science Foundation has set. First, the Project must identify common concepts that apply to many areas of computer-based education. Second, methods of evaluating the economic and teaching effectiveness of using the computer as a basis for higher education also must be developed. Third, an administrator considering initiating computer-based techniques in his institution must know the pedagogical and financial investment his school would have to make. And, the fourth goal is to point out what must be present before computer-based materials can be transferred easily from one institution to another.

Multidisciplinary

PROJECT TITLE: INTERACTIVE TV

SPONSOR: The MITRE Corporation
Westgate Research Park
McLean, Virginia 22101

PURPOSE:

The MITRE Corporation is preparing the setting for a major field study of interactive television.

AUDIENCE:

Interactive television, in this experiment, will provide a large number of cable-connected home television receivers access to individual, time-shared computer ports. From each port, a variety of individualized instructional programs and information will be made available to users.

INNOVATION:

Interactive television has evolved out of MITRE's development of a computer-assisted instruction delivery system called TICCIT (an acronym for "TIME-shared INTERACTIVE COMPUTER-CONTROLLED TELEVISION"). TICCIT uses two minicomputers to drive over 100 simultaneous interactive ports.

In a step beyond TICCIT's capability of delivering instruction in television format, MITRE has further developed and enlarged the system for implementation over a community cable television installation. Such a system was put in operation in the new city of Reston, Virginia. For over two years MITRE has demonstrated potential interactive services over a single television channel in various homes throughout Reston.

Standard home color television sets are the terminal displays. The system modulates alphanumeric and graphic information as signals for transmission to television terminals in saturated color. The system also switches video, audio and data from other program sources. Users interact with the computer by using a keyboard which communicates via the reverse path of the bidirectional CATV system.

EVALUATION:

On the basis of an extensive survey of cable systems throughout the United States, MITRE has proposed a medium size city (presently being negotiated) as the site for the study to be conducted under National Science Foundation sponsorship, beginning in August, 1974.

Profit motivation and private enterprise may be relied on to develop and exploit the more obvious commercial applications of interactive television (e.g., shopping). MITRE, accordingly, is seeking to serve the public interest by stressing the identification and development of media factors and content which will promote attractiveness and effectiveness of educational and other community services.

PROBLEMS:

In addition to the conceptualization, development and installation of the system, MITRE is responsible for the various organizations and resources integral to the conduct of a successful project. MITRE is actively seeking collaborators, suppliers and contributors to make substantive inputs. In particular, MITRE is interested in any possible sources of educational material which would benefit from the interactive delivery mode. Such sources include both adaptation of existing materials, subcontracts to develop new concepts especially to the home interactive environment, and co-experimenters to investigate the parameters of this potentially important new medium.

Physics and
Interdisciplinary

PROJECT TITLE: A PROGRAM TO CONSIDER SCIENCE, TECHNOLOGY AND SOCIAL CHANGE

PROJECT DIRECTORS: G. Webb and J. Webb

PROJECT ADDRESS: Physics Department and
Division of Humanities
Christopher Newport College
Newport News, Virginia 23606

PURPOSE:

The purpose is to develop a physics program that will address itself to the public understanding of science, provide a liberal learning experience for students, offer some pre-professional training, but not duplicate the traditional physics programs offered at our parent school, William and Mary.

AUDIENCE:

The audience is the largely liberal arts and business oriented student body of Christopher Newport, and a large segment of the community of Newport News, who return to school either for personal enrichment or as a result of a change in life-plan requiring further training in the sciences.

INNOVATION:

The first is the purpose of the Department itself. The second is that the program as a whole is organized not around courses but around larger groupings of material within which there is a large amount of flexibility. For instance, the Explorations cluster encompasses a group of courses, Astronomy, Oceanography, Meteorology, which can be offered at differing times and for differing amounts of credit. A number of courses will be taught using non-traditional teaching approaches. We hope to be able to use programmed instruction to bring all of our students to the same level.

EVALUATION:

We interview and observe selected students. We use some questionnaries, although with a certain degree of scepticism.

MATERIALS:

The only material we intend to produce is supplementary commentary on the nature of modeling in other disciplines and in other cultures.

PROBLEMS:

Our single greatest problem is the poor preparation of the students. Most of them have at least average abilities; some are very bright. Almost all of them are in the top half of their high school classes. However, the scholastic achievement of the student population has been going down dramatically over the past few years, and we anticipate that this trend will not bottom out for a while.

Biology

PROJECT TITLE: PROJECT BIOTECH

PROJECT DIRECTOR: Richard A. Dodge

PROJECT ADDRESS: American Institute of Biological Sciences
1401 Wilson Boulevard
Arlington, Virginia 22209

PURPOSE:

To produce individualized teaching modules which demonstrate a wide range of biologically related technical skills. The modules are task oriented and do not consider conceptual or philosophical questions and may be used in virtually any teaching situation requiring the learning of a biological skill or technique.

AUDIENCE:

Primarily designed for introductory biology courses and training of potential biological technicians. The modules have been used in two-year and four-year college and university classes in such courses as introductory biology, botany, zoology and microbiology. In addition, the modules have been employed in industrial and government training and research laboratories, as well as in technical institutes, high schools, and proprietary training institutions.

INNOVATION:

The modules are skill oriented, self-contained, independent units which may be incorporated singly or in groups within existing courses, programs, or training regimes. They are not designed as a curriculum, but rather, in the modular sense, are designed to "plug into" existing or newly designed programs. It is believed the instructor in the classroom, familiar with local situations, needs and resources, is the best individual to make the decision relative to curriculum design. The BIOTECH modules are intended to fit into such a curriculum when and where needed.

EVALUATION:

The modules have been evaluated in actual teaching situations in community colleges, four-year colleges and universities, primarily in introductory courses. They have been evaluated in government and private training programs and in advanced secondary classrooms. Each evaluation site is provided with an evaluation instrument for the users and an overall evaluation form for the training supervisor. The results of these responses are analyzed by the Human Factors Research Laboratory, Colorado State University.

MATERIALS:

More than thirty modules have been produced which consist of film and tape media materials, as well as printed study guides. Other materials such as Developer's Kits and workshops for potential module writers have also been produced. Exemplary materials are available from Project BIOTECH, located at the American Institute of Biological Sciences, and will shortly be published commercially.

PROBLEMS:

The most serious difficulties encountered have been the identification of suitable writers and developers of module material and the location of test sites desirous of carrying on the evaluation activities. If, with the current state of experience, the Project were beginning, a great deal more time would be spent preparing the guides for writers and developers. Test and evaluation procedures would be modified to insure a representative sample from specific test centers under greater supervision from the Project staff.

Multidisciplinary
Physics
Ecology
Computer Science

PROJECT TITLE: PHYSICAL PROCESSES IN TERRESTRIAL AND AQUATIC ECOSYSTEMS

PROJECT DIRECTOR: Benjamin A. Jayne

PROJECT ADDRESS: Center for Quantitative Science in
Forestry, Fisheries & Wildlife
3737 - 15th Avenue, N.E.
University of Washington
Seattle, Washington 98195

PURPOSE:

The major thrust of this project is that of developing an instructional program concerned with the application of physical theory to the transport of mass and energy in an ecosystem. The program of courses will be founded on the classical theories of thermodynamics, diffusion, and fluid mechanics adapted so as to be meaningful to an ecologist whether concerned with terrestrial or aquatic systems.

AUDIENCE:

The program is addressed to the upper division and graduate student in the natural sciences. We expect the students to come from a variety of backgrounds including botany, forestry, biological oceanography, zoology and fisheries. We are just now beginning the project and hence have limited experience to date.

INNOVATION:

We plan to use the computer extensively in the program in a highly interactive mode. We hope to use the computer to help the student gain insight into the solution of problems and also to observe the effect of changes in physical parameters and boundary conditions on the form of solutions. Geophysical display will receive emphasis.

EVALUATION:

We plan to develop the materials such that they can be used subsequently at a number of institutions. We are basing evaluation on the experience of colleagues in other institutions who use the materials. We intend to include a number of students in the project both as contributors and receivers. Internal evaluation will be based on their reaction as well as that of faculty in related areas.

MATERIALS:

Since the project is only about to begin, we have no materials on hand at the present time. We do have, however, many questions that might be answered in part at least by participants at a conference such as planned. At this stage, we consider our most serious difficulties to be that of developing the use of the computer in such a way as to be the foundation of the entire program.